TANK PLATOON IN THE DEFENSE: MODEL FOR ANALYSIS

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THESIS

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MODEL FOR ANALYSIS

by

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March 1979

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Tank Platoon in the Defense: Model for Analysis	5. TYPE OF REPORT & PERIOD COVERED Master's Thesis March 1979
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Henry John Schroeder, III	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93940	12. REPORT DATE March 1979
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, CA 93940	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for public release; distribution unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

tank platoon defend model training
task analysis armor

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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(Page 1) S/N 0102-014-6601

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Tank Platoon in the Defense: Model for Analysis

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
March 1979

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TABLE OF CONTENTS

I. INTRODUCTION

A. SCOPE

The presented model diagrams the integrated activities accomplished by the tank platoon in preparing for, executing, and recovering from the defense of a preselected battle position. The graphic relationships among the individual crewman level tasks, the crew level aggregates of crewman tasks, and the platoon level aggregates of crew and crewman tasks are at Appendixes D and E. A summary of sample measures of performance and the factors which potentially shape the measures is at Appendix F. The remainder of the appendixes define the model graphics.

The remainder of this chapter develops the need for the model. Enriching explanation of the graphic model is found in Chapters 2 - 4. Sample measures of platoon performance are developed in Chapter 5. Potential applications of the model are proposed in Chapter 6.

B. BACKGROUND

Land warfare is dynamically evolving at an accelerating pace. Reference 1 further states,

> "Today's battlefield presents challenges beyond any the U.S. Army has ever faced. ... We must assume the enemy we face will possess weapons generally as effective as our own. And we must calculate that he will have them in greater numbers than we will be able to deploy, at least

in the opening stages of a conflict. Because the lethality of modern weapons continues to increase sharply, we can expect very high losses to occur in short periods of time. Entire forces could be destroyed quickly if they are improperly employed. Therefore, the first battle of our next war could well be its last battle: belligerents could be quickly exhausted, and international pressures to stop fighting could bring about an early cessation of hostilities. The United States could find itself in a short, intense war -- the outcome of which may be dictated by the results of initial combat. This circumstance is unprecedented: we are an Army historically unprepared for its first battle. We are accustomed to victory wrought with the weight of materiel and population brought to bear after the onset of hostilities. Today the U.S. Army must, above all else, prepare to win the first battle of the next war. Once the war is upon us, we shall aim at emerging triumphant from the second, third, and final battles as well. ... The war in the Middle East in 1973 might well portend the nature of modern battle. ... In clashes of massed armor..., both sides sustained devastating losses, approaching 50 percent in less than two weeks of combat."

In order to survive the intense inevitable attrition of forces, the U.S. Army must continuously maintain a strong readiness posture. Military strength, however, is expensive in terms of national resources. Budgetary constraints firmly limit total potential strength and require "that some hard decisions be made on priorities as to where our first efforts should go and where less pressing needs may be temporarily set aside" according to Ref. 2. The question is not how much defense spending guarantees military, and therefore, national success. The question is how to procure the most amount of military readiness for a fixed national budget defense allocation.

One high cost item needed in large numbers is the tank. "The tank, with its crosscountry mobility, its formidable firepower, has been and is likely to remain the single most

important weapon for fighting the land battle." Reference 1 further attributes the increased intensity of the modern battlefield to the following improvements in firepower, armor protection, and mobility. To achieve a 50 percent chance of hitting a totally exposed tank at 1500 meters, the World War II medium tank needed thirteen rounds. The Korean War medium tank needed three rounds. Today's medium or main battle tank needs just one round. From 500 meters, a World War II tank round penetrated 4.8 inches of armor. From 2000 meters, today's main battle tank round penetrates 9.5 inches of armor. Today's tank has twice the armor protection of a World War II tank. A modern medium tank has one-fourth less ground pressure, one-fourth more engine power per ton of tank weight, and twice more cruising range than a World War II tank.

The tank, however, is not employed as a single isolated weapon. Reference 3 shows the tank employed in platoons of five tanks and twenty men. Additionally, the platoon is one of the basic components of larger tactical organizations using the combined arms concept. Tank platoons are further both offensive and defensive weapons systems. In the defense, the tank platoon is "the basic element of the combined arms team around which the battle is organized."

The Department of Army needs to train, equip, and maintain tank platoons. The Department of Army is required to observe its budget allocation. From the apparent conflict of goals, many questions arise. Two examples

follow. How should the Army allocate monies between tank platoons and other types of units in the combined arms context? How should the Army allocate monies between refining equipment to improve current potential effectiveness and improving training to realize more fully current potential effectiveness? In determining the effectiveness of the tank platoon in the defense, many more questions arise. Two examples follow. In actually preparing a platoon battle position under a time constraint, how should the platoon allocate manpower between obstacle construction and individual tank firing position improvement? Is the potential early warning of enemy elements afforded by an observation or listening post worth the risk of losing to enemy fire the post members who are tank crewmen and, consequently, of degrading the platoon's ability to fight?

To answer these questions according to Ref. 4, "more and more, ... analyses use force-on-force models, simulations, and war games." To answer these questions, the ability of the tank platoon to defend must be measured. If no single measure is possible, then many facets of the tank platoon must be measured. And as many of these measurements must be as quantifiable as possible. But a single exhaustive list of the measures of the tank platoon's performance in the defense is elusive.

The available training and doctrine literature for a tank platoon, Refs. 3 and 5 - 11, was reviewed. By

describing various tank platoon and tank crew activities, Refs. 3 and 5 imply many measures of performance for the defense. Reference 5 also specifies certain gunnery measures. Neither reference lists all measures nor describes a procedure for doing so. References 6 - 8 list measures for individual platoon members, but remove the measures from the context of tactical operations. The process of decision making is noticeably absent from these references. While proficiency in the use of visual signals and radio equipment is measured, for example, the decision criteria for the type of communications to use in a given situation is not measured. Reference 9 provides specified tank platoon level subjective measures of performance for various tactical missions including the defense. The platoon scenarios fail to integrate the platoon level tasks and measures with crew and individual level tasks and measures. Reference 3 does not provide an effective bridge between Refs. 5 - 8 and Ref. 9. Reference 5 provides a bridge only between individual crewman level behaviors and crew level aggregates of individual behaviors in tank gunnery. References 10 and 11 provide some measures of the platoon leader but fail to integrate his actions with those of his platoon's members. Reference 12 provides an incomplete list of measures. References 3 and 5 - 12 provide actual lists of potentially quantifiable measures of performance and imply many more. The references do not

present an exhaustive list of all measures or show the integration of platoon, crew, and crewman level activities.

Simulations and war games were sampled in References 13 and 14 in hope of finding a complete list of performance measures placed in structured relationships. The DYNTACS and CARMONETTE stochastic simulations and the Bonder IUA deterministic model list many platoon, crew, and individual performance measures and equipment engineering measures as model inputs. In all three computerized models, however, the abstract relationships among the measures are far removed from actual platoon activities. This prohibits assessment of the completeness of the inputs used. All three models also fail to incorporate one or more tank platoon activities in the defense. The models also predate current doctrinal trends. The CAMMS computer assisted war game uses aggregated equipment characteristics in _lieu_ of separate engineering measures. No human performance measures can be assessed by the nature of the war game. The DBM war game described in Ref. 15 may alleviate some of the CAMMS shortcomings. References 15 - 21 amplify Refs. 13 and 14. Although the partially and completely computerized models present a more coherent integration of selected measures, the model's inputs do not constitute a complete list of performance measures of the tank platoon in the defense. Some of the measures that are used appear questionable under the type of close scrutiny in Ref. 21.

Other studies and publications were examined for measures of performance and for a framework relating actions accomplished at various organizational levels. References 22 and 23 provide a nearly complete list of measures and a well developed methodology for obtaining the measures. Unfortunately many of the measures are vague or subjective, and the two references predate newer tactical technique trends. References 24 - 34 are a rich source of measures of performance of the tank platoon in the defense and offer alternate development methods to those in Refs. 22 and 23. Of special note is Ref. 31 which develops the relationships among many equipment measures in use in several simulations.

In conclusion, there is no single list of measures of performance which describe the tank platoon in the defense. A comprehensive list of measures will help answer the types of questions posed earlier in this section. More importantly, there is no method for obtaining such a list. There is no model that clearly shows the individual, crew, and platoon activity interaction. There is no model that clearly defines the interface between tanker and tank. There is no model that specifies the human responses to environmental stimuli. A model encompassing all these facets is proposed to guide the development of measures of performance for the tank platoon in the defense. A sample task analysis and performance measure development is offered with the model. This methodology, applied to each

individual task in context of platoon defense operations, offers the best means of developing quantifiable measures and rational measure aggregation.

II. MODEL ORGANIZATION

The model is a hierarchy of activities and actions from the platoon level through the crew level to individual crewman level along a time sequential path. The model shows the platoon level activities to accomplish the defense of a preselected battle position. The platoon level actions consist of collections of crew level and crewman level actions. Crew level activities consist of collections of crewman level activities. The model shows the crewman's reactions to the environment and his interaction with other crewmen and equipment.

A. CONSTRUCTION

The time sequential and hierarchial approach is suggested and partially exercised in Refs. 22 and 23. Most of the crewman and crew level actions are derived from Refs. 3, 5 - 8, and 10 - 11. Platoon level activities are extracted from Refs. 3 and 9 - 11. Reference 3 guides the integration of platoon level, crew level, and crewman level actions. The author's own armor experience also influences the model content.

The model graphics consist of abbreviations, relational shorthand, and computer programming flow chart symbols. Most abbreviations are non-standard. If a single word is

referenced, the abbreviation generally consists of the first 2 - 4 letters of the word. If more than one word is referenced, the abbreviation consists of the first letter of each word. The relational representations consist of shorthand for the following words: and, or, same person, and not same person. The flow chart symbols are standard FORTRAN computer language practice and non-standard extensions. The model graphics are at Appendixes A - C.

Assisting in organizing the graphic hierarchy of platoon level, crew level, and crewman level activities is a small amount of specialized vocabulary. The general terms -- activity, action, series, collection, and stream -- have their meaning fixed by the context in which they appear. The special terms -- phase, subphase, task, and sequence -- have specific meaning within the model. A phase is the broadest subdivision of the defend mission. A phase consists of one or more component subphases. A subphase is a large collection of crewman level tasks. A task is the lowest subdivision of the defend mission. In developing the subphases, small collections of related tasks appeared repetitively throughout the model. A sequence is such a group of related tasks. In a computer programming sense, a sequence is similar to a subroutine. A sequence may be embedded in another sequence as well as in a subphase. Within a sequence, a component sequence is treated as though it is a component task. Within a subphase, a component sequence is also treated as through it is a component task.

To assist the reader in locating a task referenced in the model narrative, an arbitrary numbering system identifies each task in the diagrams. When developing sequences in Chapter 3, each task shown in Appendix D is identified by the letter S followed by a number. For example, task S34 refers to a task arbitrarily numbered as 34 in a sequence. When developing subphases in Chapter 4, each task shown in Appendix E is identified by the subphase number followed by a decimal and the task number. For example, task 7.5 refers to task 5 in subphase 7. There is no relationship between the sequence and subphase numbering systems. Many tasks appear in several sequences and several subphases. In this case the task number will be different in each location. The task numbers serve only to identify tasks in the diagrams and the diagram explanations.

Several potential facets of the tank platoon in the defense are omitted from the model. Simplifications to the process of conducting a defense include the following: platoon section organization; presence and sustained operability of equipment; nuclear, biological, and chemical effects; non-standard signalling methods of noise, pyrotechnics, and colored panels; platoon standard operating procedures; and radio frequency jamming effects.

In the model, the platoon is organized with the platoon leader controlling the heavy section and the platoon sergeant controlling the light section. When the platoon is moving into a battle position, the heavy section leads the

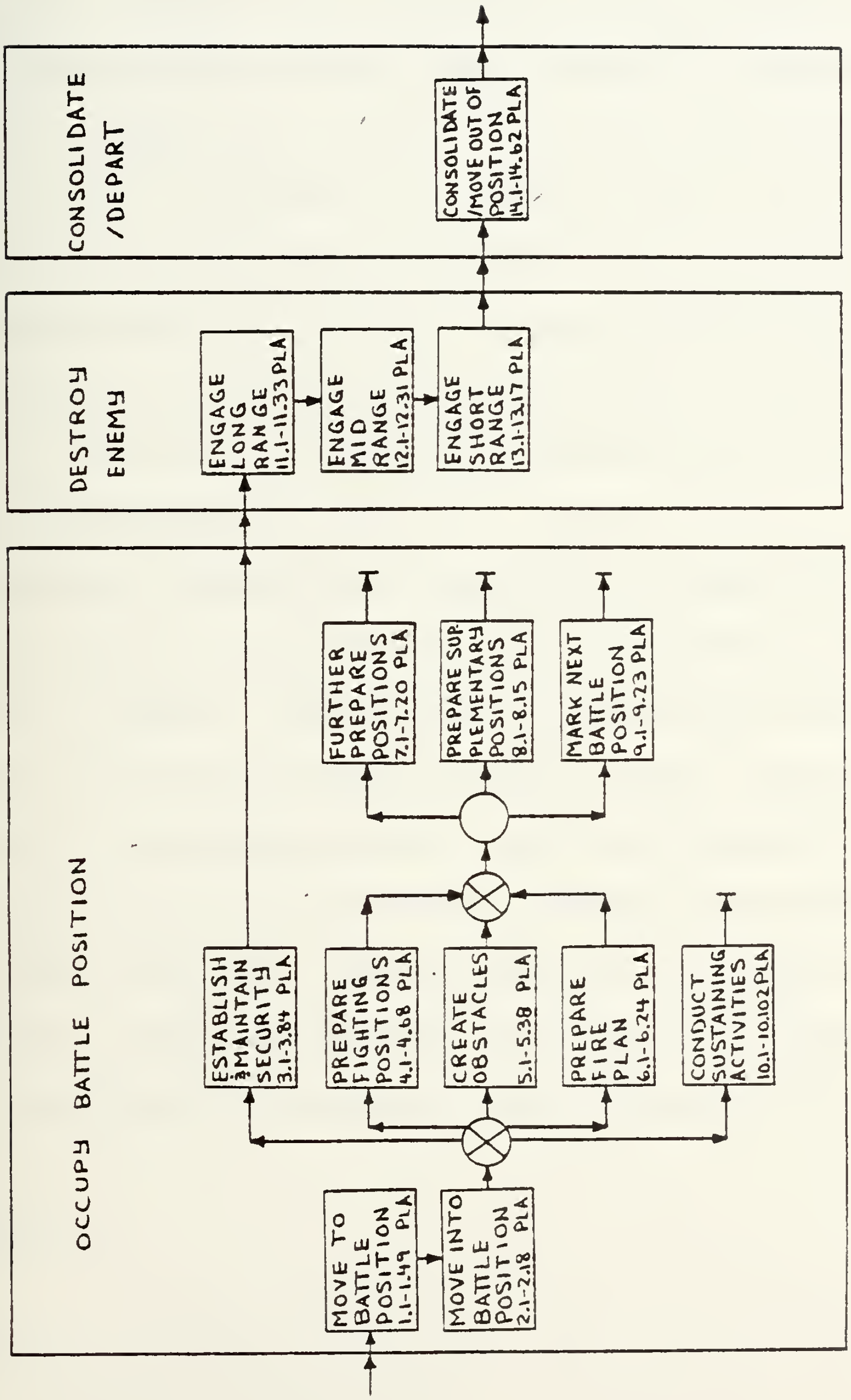

OCCUPY BATTLE POSITION
DESTROY ENEMY
CONSOLIDATE /DEPART
MOVE TO BATTLE POSITION 1.1-1.49 PLA
MOVE INTO BATTLE POSITION 2.1-2.18 PLA
ESTABLISH & MAINTAIN SECURITY 3.1-3.84 PLA
PREPARE FIGHTING POSITIONS 4.1-4.68 PLA
CREATE OBSTACLES 5.1-5.38 PLA
PREPARE FIRE PLAN 6.1-6.24 PLA
CONDUCT SUSTAINING ACTIVITIES 10.1-10.102 PLA
FURTHER PREPARE POSITIONS 7.1-7.20 PLA
PREPARE SUPPLEMENTARY POSITIONS 8.1-8.15 PLA
MARK NEXT BATTLE POSITION 9.1-9.23 PLA
ENGAGE LONG RANGE 11.1-11.33 PLA
ENGAGE MID RANGE 12.1-12.31 PLA
ENGAGE SHORT RANGE 13.1-13.17 PLA
CONSOLIDATE /MOVE OUT OF POSITION 14.1-14.62 PLA

fig 2-1

light section. When the platoon is moving out of a battle position, the heavy section follows the light section. In reality, the sections' roles and the section leaders' identities can be reversed.

The model assumes that equipment required for a task is present and operable, except where otherwise explained. The model also assumes the equipment to remain operational during its use. In reality, equipment often fails during use or becomes otherwise unavailable for continued use. Examples include radio failure during a transmission or tank immobilization during movement between battle positions. The latter may be due to effective enemy fire or to the tank becoming mired in soft soil.

Battlefield operational complexity increases with radio frequency jamming and with the advent of nuclear, biological or chemical weapons. Non-standard communication methods supplement the use of standard visual, wire, and radio communication. A platoon standard operating procedure may make routine many tactical activities including non-standard signals. These facets are real possibilities on the modern battlefield. These parameters should be incorporated in later generations of the basic model presented here.

B. OVERVIEW

A macro-version of the model, figure 2.1, serves as a table of contents for the specific elements in the model. The platoon defense mission is divided into three major time

sequential phases. The phases of occupy the battle position, destroy the enemy, and consolidate or depart are shown on the upper portion of the figure. Each phase is divided into subphases that are also time sequential. To a limited degree a particular series of tasks could be transferred from one subphase to another without affecting the model. For example, the series of tasks addressing the concealment of a tank fighting position found in subphase 4 could be moved to subphase 3 without loss of model generality.

To occupy the battle position, the platoon first moves to the battle position using the appropriate movement techniques during subphase 1. Once there, the platoon completes subphase 2, moving into the battle position, by fitting the tanks to the ground. Subphases 3, 4, 5, 6 and 10 start simultaneously. The platoon immediately establishes security and then maintains security for the duration of the first phase. The crews prepare their tank fighting positions, subphase 4. In subphase 5, the platoon creates obstacles. The platoon leader and tank commanders prepare the platoon fire plan, subphase 6. In subphase 10, the platoon conducts sustaining operations which may continue for the duration of the first phase. Once subphases 4, 5, and 6 are completed, the platoon initiates subphases 7, 8, and 9. The crews further prepare their tank fighting positions and prepare supplementary positions, subphases 7 and 8. Selected platoon members mark the next battle position, subphase 9.

All activities occurring in the first phase cease, whether completed or not, when the criteria for entering the second phase are met. The destroy enemy phase consists of at least one and possibly three subphases. The platoon engages the enemy at long range when the enemy is within range of indirect fire adjusted by the platoon but beyond range of the platoon's tank cannons. Environment masking or mission limited opening ranges may proscribe subphase 11. The platoon engages the enemy at midrange when the enemy is within platoon direct fire range but before the enemy begins delivering effective direct fire against the platoon's tanks. Subphase 12 is always initiated. When the enemy begins returning effective direct fire, subphase 12 gives way to engaging the enemy at short range if the platoon conducts a restrictive defense. If the platoon conducts a nonrestrictive defense, the platoon does not initiate subphase 13.

If the platoon executes and survives subphase 13, the platoon reorganizes and consolidates the battle position. If the platoon executes only subphase 12 because of a nonrestrictive mission, the platoon moves out of the battle position. The destination may be another battle position. The activities accomplished in subphase 14 depend on the platoon's defensive mission.

Each subphase is dissected in Chapter 4. The recurring sequences appear in Chapter 3. In both chapters, the collections of activities are resolved to individual crewman level detail.

III. SEQUENCES

The sequences, recurring groups of related crewman level tasks, are generally tactical or administrative in nature. The tactical sequences are collections of skills with the distinctly armor goals of move, shoot, communicate, or see. The administrative sequences are generally cognitive decision processes or chain of command actions. The remarks in this chapter are designed to expatiate the figures in Appendix D. The numbering system serves only to relate the following discussion to the tasks in figures D-1--D-8.

A. DISMOUNTED MOVEMENT

The dismounted movement sequence, figure D-1, is one of the basic military skills. The crewman moves from his current location to a destination location. A destination can be designated by five different methods. The destination can be designated by proxy of either grid or polar coordinates. The destination can be designated physically on the ground, such as a neighboring tank or a nearby visible terrain feature. The destination can be designated by a route marked either to or beyond the destination.

When the destination is designated by proxy, the crewman first determines if he can see the final destination location on the ground, task S1. If the crewman decides he

cannot see the destination and is using grid coordinates, he selects a route on a map, task S2. If the crewman decides he can see the destination and is using grid coordinates, he selects a route on the ground, task S3. If the crewman is using polar coordinates, he selects a route on the ground. If the crewman decides he can see the destination, the route extends to the final destination. If the crewman decides he cannot see the final destination, piece-wise routes connect interim destinations leading to the final destination. If the destination is designated physically, the crewman selects a route on the ground. Regardless of the method of destination designation, the crewman land navigates over the route to his destination, task S4.

B. MOUNTED MOVEMENT

The mounted movement sequence parallels the dismounted movement sequence. The same five destination designation methods apply. Task S5 duplicates task S1. Tasks S6 and S7 are like tasks S2 and S3, except the former refer to a tank route. Task S8 is similar to task S4, except that land navigation is mounted. In order to accomplish task S8, the tank commander and driver interact. In task S9, the tank commander instructs the driver in destination or direction of travel and rate of movement. The driver operates the tank in task S10 in response to the tank commander's instructions.

C. SECTION MOVEMENT

Where the mounted movement sequence considers individual tank movement, the section movement sequence addresses movement of a section of tanks. The section leader, either platoon leader or platoon sergeant, initiates this sequence by transmitting movement instructions to the other tank commanders in his section, task S11. Each of the crews in the section execute the mounted movement sequence, task S12. The section leader transmits a message to halt in task S13. Each of the tank commanders selects a tank fighting position, task S14. In task S15, each of the crews places their tank in the selected fighting position. The tank commander may execute task S14 in either section movement or individual movement. Task S15 may also apply to group or individual movement. Specific crew actions in task S15 vary if the site is unmarked, marked for reoccupation, or staked and marked for range card use and reoccupation.

D. TRANSMIT MESSAGE

To get the individual tanks into fighting positions through the section movement sequence, the transmit message sequence was used. This sequence, figure D-2, also applies throughout the model. Task S16 requires the tank commander to decide if physical delivery of a message is the best method of transmission. A message is physically delivered by tank or by messenger. Physical delivery is the best

method for sketches and lengthy instructions. If the tank commander decides to physically deliver the message he then decides which of the two means are better, task S17. If messenger is chosen, the tank commander designates and instructs a messenger who then moves to the addressee, delivers the message, returns to his own tank, and remounts his station, tasks S18-S22. Task S22 generally applies to any crewman finishing any task requiring his presence outside of his tank. If delivery by tank is chosen, the tank commander directs his tank and crew to the addressee, delivers the message, and directs tank and crew back to their previous location; and the crewmen resume their previous activities, tasks S23-S26.

If physical delivery is not necessary, the tank commander decides if visual signals are viable, task S27. If so, he sends the message by means of standard hand and arm, flag, or flashlight signals, task S28. If visual signals are not viable and wire communication is available, the tank commander transmits the message by wire communication, task S29. If wire communication is not available and radio listening silence is not in effect, the tank commander transmits the message by radio, task S30. If radio listening silence is in effect, only physical delivery is left as the means of transmission. The decision in task S17 and resulting actions have already been described.

Having attempted to transmit the message, the tank commander decides if the message reached its addressee, task

S31. The tank commander bases his decision on receipt of a required acknowledgement or the initiation of an immediately required and visible obvious action. If the tank commander decides the message is not received, he restarts the process at task S16. If the tank commander decides that the message is received and the message requires some obvious immediate action, he decides if the message is understood, task S32. If the tank commander decides the message is understood, he finishes the transmit message sequence. If the tank commander decides the message is misunderstood, he restarts the sequence at task S16.

E. RECEIVE MESSAGE

Complementing the transmit message sequence is the receive message sequence. In task S33, the message recipient decides if he understands the message. If so, he then decides if an answer is required in task S34. If so, he transmits the answer using the transmit message sequence, task S35, and completes the receive message sequence. Radio telephone procedures require at least an acknowledgement for wire and radio communications. Visual signals may not require an acknowledgement. If the tank commander decides no answer is required, he completes the sequence.

On the other hand, the addressee may decide he does not understand the message. If the platoon is not moving to or out of a battle position, the recipient transmits a message requesting the repeating or clarifying of the original

message, task S36. The sequence begins anew with task S33. If the platoon is moving and the message sender is not the addressee's section leader, the recipient executes task S36 also. If the message originator is the recipient's section leader, the addressee imitates the section leader's actions, task S37. This task normally consists of stopping the tank in a selected firing position or moving out of a firing position in a direction paralleling or following the section leader's tank. Resorting to the follow-me-and-do-as-I-do principle also completes the receive message sequence.

F. TARGET ACQUISITION

The transmit and receive message sequences often follow the discovery of a target during the target acquisition sequence, figure D-3. In task S38, the crewman must observe and listen in his assigned sector of responsibility. He must decide if there is activity in his sector during task S39. Activity may include noise; light; smoke; dust; or aircraft, vehicle, personnel, or animal presence or movement. If the crewman decides there is no activity, he continues to observe and listen in his sector. If the crewman decides there is activity, he must decide if the activity is caused by potential, live enemy elements, task S40. If the crewman decides the activity is not a target, he continues to observe and listen. Otherwise, the crewman tells the tank commander of the target, if the two men are not the same, task S41. The sequence is finished once the tank

commander knows of the target. The crewman must look and listen, see and hear, identify, and tell.

G. FIGHTING POSITION

The fighting position sequence always follows a target engagement sequence which may follow a target acquisition sequence. In the fighting position sequence, the tank commander decides if the tank and crew must move. If so, the decision then is whether to move to the other fighting position or to the hide position. A move from the primary fighting position to the alternate fighting position, or _vise versa_, depends on the perceived intensity or accuracy of return fire occurring or about to occur. The crew moves the tank to the hide position if tank, crew, or both cannot fight. If the cause of the inability to continue combat can be fixed, the crew moves the tank back to one of the fighting positions. If the ability to fight cannot be restored, the tank and crew remain in the hide position.

In task S42, non-operational tank cannon or direct fire controls, injured crewman, or lack of cannon ammunition causes a move to the hide position. Barring such a move, the tank commander decides if a move to the other fighting position is propitious in task S43. If he elects to remain in the present fighting position, he finishes the sequence. If he selects the other fighting position, the crew moves the tank and places it in the position, tasks S44 and S45. If the tank commander selects the hide position, he informs

the platoon leader while the crew moves the tank and places it in the position, tasks S46-S48.

The tank commander selects the hide position for the reasons shown in the vertical series of decision and default diamonds. If the cannon or direct fire controls are malfunctioning, the crew decides if they can correct the fault, and the tank commander informs the platoon leader, tasks S49-S50. Although the tank machineguns may function, the tank is not effective unless its primary armament system is operational. The crew fixes the fault, if correctable, in task S51; the tank commander selects a fighting position in task S52; and the crew executes tasks S44-S45. If a crewman is injured, the crew applies first aid, and the tank commander decides if the crew can still fight, tasks S53-S54. A three man crew can fight the tank, albeit less efficiently, by occupying the driver, loader, and commander stations. After the tank commander informs the platoon leader in task S55, the crew executes tasks S52 and S44-S45, if the crew can still fight the tank. Simultaneous occurrence of both primary armament and crew damage results in the integrated execution of tasks S49-S51 and S53-S55.

Damage is not the only reason for seeking the hide position. The crew may have fired all main gun ammunition in the turret. If there is ammunition remaining in the hull storage compartments, the crew shifts rounds into the turret storage racks in task S56; the tank commander informs the platoon leader in task S57; and the crew completes the

remainder of the sequence. If all tank rounds are expended, the tank commander can only inform the platoon leader in task S58 and remain in situ.

H. TARGET ENGAGEMENT

The fighting position sequence immediately follows the target engagement sequence. In the latter sequence, figure D-4, the tank commander selects the most dangerous target, if more than one, in task S60 and selects the tank weapon to engage the target in task S59. Given target and weapon, the crew completes the crew duties shown in task series SA-SC.

If the cannon is selected, figure D-5, the tank commander issues an initial fire command while determining the range to the target in tasks S61-S62. The loader loads the main gun in task S63. The gunner finds the target and aims at it in task S64. If the gunner or gunner's fire controls are non-operational, the tank commander aims the cannon. Upon the loader's and gunner's task completion, the tank commander finishes the fire command. The gunner or tank commander fires the round in task S65, and both crewmen sense the round in task S66. If the tank commander decides the target is destroyed in task S67, he terminates the engagement in task S68 and finishes the sequence. If he decides the target was not destroyed, he decides if the target can be destroyed in task S69. Decision criteria include ammunition potential target effects, change in the target's cover and concealment, and target range. If the

tank commander decides the target cannot be effectively engaged, he ends firing. On the other hand, he decides if additional fire requires a subsequent fire command in task S70. Appropriateness of ammunition and the gunner's ability to adjust fire may influence the tank commander's decision. If the tank commander elects to issue a subsequent fire command, the crew carries out tasks S71-S73. If the tank commander decides against a subsequent fire command, the loader and gunner engage the same target with the same ammunition type. After firing a second round, the process flows back to task S65, sensing the round, and repeats until the tank commander stops the firing.

The sequence of actions to fire the coaxially mounted machinegun, figure D-6, is similar to that for the main gun. Tasks S74-S77 closely resemble tasks S61-S64, except that the loader loads the machinegun if necessary and arms it in task S77. The loader, gunner, or tank commander may fire the machinegun, and the latter two crewmen may adjust the aimpoint as necessary in task S82. While the machinegun is in use, the loader is responsible for maintaining the flow of ammunition to the weapon in tasks S83-S84. Sensing the fire's impact and judging target effects in tasks S78-S79 occur concurrently with firing the weapon. The tank commander stops the engagement in task S80 if he decides the target is destroyed or if he decides the target cannot be destroyed in task S81. The decision criteria are similar to

those for the cannon. Firing continues as long as the tank commander thinks the target is not yet but can be destroyed.

The sequence of tasks S85-S94 for firing a commander's station turret-top weapon are identical to those for firing the coaxially mounted machinegun with two differences. The tank commander does not determine range, and he does execute all actions required to fire the weapon. If a single turret-top automatic weapon is mounted at the loader's station on future tanks, then the loader carries out tasks S85-S94, except perhaps issuing a fire command. If future tanks mount turret-top weapons at both loader's and commander's stations, another task series similar to SC could be added to the sequence.

I. CALL FOR FIRE

In _lieu_ of the target engagement sequence, the call for indirect fire sequence, figure D-7, may follow the target acquisition sequence. In task S95, the platoon leader requests mortar or artillery fire from the company team who processes the target data and tells the platoon leader when to observe for fire. If the platoon leader cannot observe the fire, he informs the fire request originator to observe the fire effects in task S96. The observer senses the impact and determines if the desired target effects are achieved in tasks S97-S98. If the observer decides the target is destroyed or neutralized or can no longer be effectively engaged in task S101, the verdict is relayed to

the company team in tasks S99-S100. Decision criteria for determining actual or potential target effects are similar to those regarding the tank cannon. If the desired outcome is not yet but can be achieved, the observer determines fire adjustment data and relays it to the platoon leader if required in tasks S102-S103. The process restarts at task S95 and repeats until the observer stops or the company team aborts the fire mission. Platoon personnel request indirect fire because mortar and artillery forward observers are not usually attached to the tank platoon.

J. ACTION TYPE 1

The discussion of the call for fire sequence completes the purely tactical sequences. The action type 1 sequence, figure D-7, is the first of the administrative sequences. This sequence embodies the movement of a requirement down the chain of command. The platoon leader selects and instructs the tank commanders to supervise the action's accomplishment in tasks S104-S105. In turn, the tank commanders designate and instruct crewmen to carry out the directive, and they secure the equipment required to do the job in tasks S106-S108.

K. ACTION TYPE 2

Where the previous sequence begins a series of actions, the type 2 action sequence ends a series. This sequence is

related to emplacement of obstacles or early warning devices. Here the returning crewman mounts his own tank station in task S109 while the tank commander reports the work party's return, job completion, and obstacle or device locations in task S110.

L. DECISION TYPE 1

Like the action sequence type 1, the type 1 decision sequence, figure D-8, starts a series of actions. Here an order does not flow down the chain of command, but rather the platoon leader alone makes a series of decisions. An example of the sequence is the employment of linear and point hasty minefields. If mines are not available, the platoon leader does not execute this sequence. If mines are available and the company team requires minefields but did not specify their locations, the platoon leader selects locations after analyzing terrain and mission in task S111. The platoon leader must also decide if available mines exceed company team requirements in task S112. If not, he finishes the decision sequence. If mines remain after meeting any existing company team requirements, the platoon leader decides if his platoon would benefit from minefields in task S113. If the platoon leader decides the platoon does not require mines, he finishes the sequence. Conversely, he then decides if company team permission is required to use mines in task S114. Employment of hasty minefields or other obstacles which limit mounted movement,

such as road blocks or craters, generally requires permission. Employment of early warning devices and obstacles to dismounted movement generally does not. If the platoon leader's request in task S115 is denied, he completes the sequence. If his request is approved, he selects locations in task S116.

M. DECISION TYPE 2

Unlike the type 1 decision sequence, the decision sequence type 2 is not restricted to the platoon leader. An example is the improvement of natural concealment at a fighting position. In task S117, the tank commander decides if his position would profit from added concealment. If so, he decides if adding concealment is possible in task S118. Competing demands for available time, *matériel*, and manpower strongly color his decision.

The tactical and administrative sequences are used throughout all the subphases described in the next chapter. Within each subphase, each sequence is treated as though it is a task. The only difference is that each sequence is a collection of crewman level tasks where each task is a single crewman level task.

IV. SUBPHASES

The subphases are time sequential major collections of tasks and sequences. The component tasks and sequences depict the platoon activities in defense of a preselected battle position in time sequential individual crewman level detail. The model shows the dynamic interface of crewmen with each other, their equipment, and their environment. The remarks in this chapter are designed to amplify the figures in Appendix E. The numbering system serves only to relate the following discussion to the tasks in figures E-1--E-28.

A. MOVE TO BATTLE POSITION

To conduct a defense of a preselected battle position, the platoon must first move to the position, figure E-2. In this subphase, there are five major series of tasks occurring simultaneously. The platoon leader decides if the enemy has acquired his platoon and acts accordingly. The platoon, however, strives to detect the enemy first by all-around observation. The actual movement is shown by series 1A. The platoon uses the travelling technique when enemy contact is not expected and a rapid movement rate is desired. The platoon uses travelling overwatch when enemy contact is possible but rapid movement is desired. The platoon uses bounding overwatch when contact is expected.

The platoon leader constantly evaluates his selected movement technique based on the potentially changing perceived tactical situation. Lastly, coordinated movement to the battle position depends on communication.

In task 1.1, the platoon leader decides if the platoon is under effective fire. If so, he determines if the fire is direct, indirect, or mixed, and reports the situation to company team in tasks 1.2-1.3. If the platoon or affected section is moving under mortar or artillery fire only, it simply continues to move. If the platoon or section is temporarily stopped when the indirect fire starts, the platoon or section leader selects a new position and leads his elements to the new position in tasks 1.4-1.5. If any part of the platoon is under direct fire, the platoon immediately adopts a hasty defense. Here the platoon leader selects a battle position and informs company team of his course of action in tasks 1.6-1.7. If the light section is not at the battle position, the platoon leader informs the platoon sergeant who directs his section to the position, tasks 1.8-1.10. At the same time, if the heavy section is not at the battle position, the platoon leader directs his section there through tasks 1.11-1.12.

Finding the enemy first, however, is more desirable. To this end, the platoon leader selects sectors of observation for every tank commander and tells them of their assigned sectors in tasks 1.13-1.14. The tank commanders assign subsectors to their crewmen, and the crew observes for enemy

personnel, vehicles, and aircraft in tasks 1.15-1.16. If a target is found, the platoon leader is informed, and he informs company team in tasks 1.17-1.18. The platoon goes into a hasty defense starting the series of actions at task 1.6. Although the model provides exercise of the hasty defense, a detailed discussion of the hasty defense is outside the scope of this paper.

In order to relay acquired targets and transmit and receive other messages, each tank commander monitors his radio and watches other tank commanders for visual signals. Tank commanders who are not section leaders observe their section leaders for hand and arm, flag, or flashlight signals in tasks 1.20-1.21. The platoon sergeant watches the platoon leader for visually transmitted platoon orders in tasks 1.22-1.23. All tank commanders monitor the platoon radio net, and the platoon leader monitors the company team command net in tasks 1.24-1.25. A message recipient responds accordingly in task 1.26.

The purpose of subphase 1 is to move to a designated battle position. The platoon leader selects a movement technique and informs his platoon sergeant of the technique in tasks 1.27-1.28, figure E-3. While the platoon is moving, the platoon leader changes the technique as required by task 1.19. The platoon moves as a single unit or as complementing sections. When using the travelling technique, the platoon moves together. While the platoon

leader is navigating to the battle position, the heavy and light sections follow his lead in tasks 1.29-1.31.

The platoon moves as reinforcing sections in travelling overwatch. While the platoon leader land navigates to the battle position, only the heavy section closely follows him in tasks 1.32-1.33. The platoon sergeant's section follows at a distance in order to fire and maneuver if the platoon leader's section experiences effective direct fire. The platoon sergeant determines the most potentially dangerous, possible enemy position in the heavy section's route of travel in task 1.34. He then selects a position from which his section could fire on the enemy position in task 1.35. The platoon sergeant moves the light section to the overwatch position in tasks 1.36-1.37. Once there, the platoon sergeant decides if his section can momentarily halt. While stopping may be desirable, the platoon sergeant cannot allow the heavy section to outrun his section's overwatch in task 1.38. If a halt is possible, the light section occupies temporary fighting positions in tasks 1.39-1.41. In any case, the platoon sergeant decides when the overwatch position no longer serves its purpose in task 1.42, and he restarts the process at task 1.34. When the platoon leader reaches the battle position, he calls the light section to join his section in tasks 1.43-1.44.

As in travelling overwatch, the platoon moves by sections in bounding overwatch. The platoon leader land navigates to the battle position in task 1.45. In tasks

1.46-1.47, the platoon leader selects an interim platoon position and directs his section to it. While the heavy section is <u>en route</u>, the light section provides overwatch. When the heavy section is escounced in the position, the platoon leader calls forward the platoon sergeant who leads his section to the heavy section's location in tasks 1.48-1.49. The process repeats until the platoon has arrived at the battle position.

B. MOVE INTO BATTLE POSITION

Having arrived at the battle position, the platoon moves into the battle position by fitting the tanks to the ground during subphase 2, figure E-4. There are three major courses of action in this subphase. If the primary fighting positions and sectors of observation are marked, the tank commanders move their tanks to the positions without the platoon leader's direction. If the positions are not marked, the platoon leader may specify sectors and positions by radio. If the tactical situation permits, the platoon leader and his tank commanders determine the best positions and sectors during a dismounted reconnaissance.

Given an unmarked battle position, the platoon leader determines sectors and general primary fighting position locations from his tank in tasks 2.1-2.2. If the platoon leader decides supplementary fighting positions are prudent in task 2.3, he also selects general supplementary primary fighting position locations and sectors in tasks 2.4-2.5.

If time and tactical situation allow, the platoon leader generally opts for a dismounted inspection of the battle position in task 2.6. In this case, the tank commanders join him on the ground in the refinement of selection of sectors and general primary fighting position locations in tasks 2.7-2.11. Once the reconnaissance is completed, all tank commanders return to their own tanks in task 2.12. If the platoon leader decides against a dismounted reconnaissance, he radios the general position locations and sectors to the tank commanders in task 2.13. Regardless of the method of fitting tanks to the terrain, the tanks and crews move to the general position locations in task 2.14. After each tank commander selects a specific site, his crew places their tank into the site while the tank commander selects alternate fighting and hide position sites in tasks 2.15-2.18.

C. ESTABLISH AND MAINTAIN SECURITY

The platoon generally places a high priority on establishing security after settling into the position. Subphase 3, figures E-5--E-8, illustrates how the platoon establishes and maintains security. There are four major series of activities in this subphase. The platoon leader monitors all reports to decide when the enemy is within range of platoon controlled fires and immediately informs the company team when so in tasks 3.1-3.3, figure E-5. Each of the tank commanders designates a mounted sentry who is

the primary means of security. The platoon may employ a listening or observation post. Finally, the platoon may employ early warning devices to augment the sentries and post. These activities generally focus on detecting the enemy first.

The mounted sentry performs as a tank commander while the actual tank commander accomplishes other position occupation tasks. After appointment, the mounted sentry mounts the commander's station in tasks 3.4-3.5, figure E-6. He monitors the radio, watches neighboring tanks for visual signals, and replies as required in tasks 3.6-3.11. The mounted sentry attempts to detect the enemy in his crew's assigned sector. In tasks 3.12-3.14, he monitors the early warning device receiver if one is aboard. In tasks 3.15-3.23, he monitors specific subareas of his sector as appropriate for enemy activity. The mounted sentry also looks and listens over the entire assigned sector in tasks 3.24-3.26. He relies on many cues to enemy presence: audio signals from early warning devices; light from trip flares; and noise, light, dust, smoke and other activity throughout his sector, at obstacle sites, and at the listening or observation post. If the mounted sentry detects enemy presence, he tells his tank commander and platoon leader in tasks 3.27-3.28.

One of the tanks provides mounted sentry overwatch for the listening or observation post. Tasks 3.29-3.30, figure E-7, are a simplified type 1 decision sequence. Because the

platoon has only one AN/GRC-39 radio set with which to provide communication between the post and the platoon, the platoon can only mount one post. If a post is to be employed, the platoon leader selects a tank commander to monitor the site and one or more crews to provide manpower and disseminates the plan in tasks 3.31-3.34. In tasks 3.35-3.42, the crewmen designated to mount the post move the radio set to the monitor tank. While selecting a route to the general post location, the crewmen set up the radio set's home module on the monitor tank, tasks 3.43-3.44. In tasks 3.45-3.47, the crewmen lay, cover, and conceal the set's communication wire while moving to the post. Having arrived, they select and settle into a specific site and prepare the telephone link for communication in tasks 3.48-3.51.

The crewmen execute three general activities at the post. They monitor the set's remote module, responding when required in tasks 3.52-3.54. They, of course, watch and listen for the enemy, reporting when necessary in tasks 3.55-3.56. They also, however, periodically check the platoon position for noise, light, and smoke which is reported to the tank commander nearest the indiscipline, who corrects the problem in tasks 3.57-3.60.

Akin to manned detection posts are the unmanned early warning devices, figure E-8. The platoon generally employs electrical acoustic devices such as the patrol seismic intrusion device or unattended ground sensors,

mechanical acoustic devices such as pebble-filled tin cans on a string, or light devices such as a trip flare. To use electrical acoustic devices, the platoon leader selects a crew to monitor the receiver, who then secure the receiver and install it on the monitor tank in tasks 3.62-3.70. All types of early warning sensors must be physically emplaced in the platoon's area of responsibility. In tasks 3.71-3.76 the platoon forms one or more work parties which move to the employment locations. The work party plants each sensor individually, arms and conceals it, and notes its location on a topographic or sketch map in tasks 3.77-3.81. The process repeats for each device at the same general location and for all locations as required. Finally the work party members return to their respective tanks and the actual site locations are relayed to the platoon leader in tasks 3.82-3.84.

D. PREPARE FIGHTING POSITIONS

While establishing and maintaining security, each crew begins preparing their tank's positions. In subphase 4, figures E-9--E-10, there are five major activity thrusts. Each crew reduces potential detection of three items: their tank, their tank's positions, and their tank's track trail leading into the fighting positions. The fourth activity provides relatively secure wire communications. The last activity is the marking of routes and sites and the preparation of range cards. The first four activities aim

toward reducing detection of the battle position location and organization. The last activity strives for improving the platoon's ability to deliver fire on the enemy.

In tasks 4.1-4.4, figure E-9, the tank commander decides if camouflaging his tank is beneficial, and if so, the series of tasks are completed. In tasks 4.5-4.8, he makes the same decision regarding the camouflaging and concealing of his primary fighting position with the same possible resulting series of tasks. In tasks 4.9-4.15, the tracks leading into the primary fighting position are camouflaged and concealed if such action is profitable.

The enemy may detect the battle position visually or by radio signature. To provide rapid communication not having an electronic emission, the platoon may opt, or be directed by company team, to use the hot loop in task 4.16. If the platoon is to install wire communication connecting all tanks, the platoon leader so directs the tank commanders who task their crewmen to hook up wire in tasks 4.17-4.18. While hooking up wire to his own tank, each crewman selects a route to a specified neighboring tank in tasks 4.19-4.20. Tasks 4.21-4.22 find the crewman covering and concealing the wire as he moves to the next tank. Once there, the dismounted crewman hands off the wire to the mounted sentry in task 4.23. While the dismounted crewman returns to his own tank station, the mounted sentry hooks the wire into his tank's communication equipment in tasks 4.24-4.26.

In addition to denying detection of the battle position, each crew can also improve their ability to put steel on target in three ways. The crew can improve the accuracy of fire, reduce nonfiring travel time between positions, and closely check the viability of positions and connecting routes. In figure E-10, tasks 4.27-4.40 and 4.54-4.68 accomplish the first, and tasks 4.41-4.53 accomplish the second and third. If the tank commander decides, or is directed, to prepare a range card in task 4.27, he designates which crew members will do the preparation in task 4.28. He then selects direct fire potential target sites for which the crewmen determine weapon and searchlight data and mark it on the range card in tasks 4.29-4.32. In tasks 4.33-4.36, the crew carries out similar actions for indirect fire potential target locations. For a range card to be effective once the tank is moved from and later returned to the position for which the range card is prepared, the crew stakes the site in tasks 4.37-4.40.

To speed protected movement between positions and closely scrutinize hastily selected sites, the tank commander and possibly one helper mark all positions and interconnecting routes during a dismounted inspection. In tasks 4.41-4.42, the tank commander and a selected crewman secure marking tape, stakes, or other materials. The work party marks all positions finally selected by the tank commander in tasks 4.43-4.47. In tasks 4.48-4.52, the work party marks all interconnecting routes finally selected by

the tank commander. There is interaction between site and route selection. When finished, the tank commander and crewman remount the tank in task 4.53. If a range card is not being prepared, the crew finishes the 4A series of tasks.

If the crew prepares a range card for the primary fighting position, they also prepare a range card for the alternate fighting position. The crew moves their tank into the now marked alternate fighting position over the now marked route in tasks 4.54-4.55. Tasks 4.56-4.59 for the alternate fighting position duplicate tasks 4.5-4.8 for the primary fighting position. Tasks 4.60-4.63 duplicate tasks 4.37-4.40. Tasks 4.64-4.66 duplicate tasks 4.28 and 4.31-4.32. Having prepared the alternate fighting position, the crew moves back into the primary fighting position site in tasks 4.67-4.68.

E. CREATE OBSTACLES

Many actions can improve the efficiency of platoon fire. Gunnery precision and interposition travel time can be enhanced as shown in subphase 4. Obstacles can improve fire efficiency by channelizing and impeding enemy movement, thus prolonging the enemy's exposure duration. Obstacles may also directly attrite enemy forces. The creation of obstacles, figure E-11, is subphase 5. There are three categories of obstacles: hasty minefields, barbed wire, and other obstacles such as a road block, ditch, or abatis. The

three types of obstacles can be used together and with early warning devices. Mines may complement barbed wire. A claymore mine may be command detonated in response to activity signalled by an acoustic early warning device. Obstacle construction bears striking similarity to early warning device emplacement, although the ends are radically different.

If the platoon employs a hasty minefield as a result of task 5.1, the chain of command action in task 5.2 results in a work party. Tasks 5.3-5.8 are very similar to tasks 3.76-3.81, figure E-8. If there is a lane through a linear minefield, the work party also notes its location on a topographic or sketch map in task 5.9. When all mines are emplaced at each minefield location and all locations are serviced, the work party returns to the battle position and reports the sites in tasks 5.10-5.12.

The platoon may designate a work party to emplace barbed wire obstacles in tasks 5.13-5.14. The selected crewmen move to each obstacle location in turn, set up the wire, and conceal it as required in tasks 5.15-5.19. Having noted the site or sites, the work party returns and reports in tasks 5.20-5.23.

If the platoon employs other obstacles, the work party executes much the same action as for barbed wire obstacles. The primary differences are in the use of explosives for cratering and felling trees in tasks 5.28-5.30 and in the

general construction work in tasks 5.31-5.32. Otherwise, tasks 5.24-5.27 correspond to tasks 5.13-5.16. Tasks 5.33-5.37 are essentially the same as tasks 5.18-5.23.

F. PREPARE FIRE PLAN

The platoon leader integrates the security measures, preparation of fighting positions, and creation of obstacles explained in subphases 3 - 5. In subphase 6, figure E-12, he organizes the battle position as a whole through developing a fire plan. In tasks 6.1-6.2, he selects potential target locations and target reference points. In tasks 6.3-6.9, he notes on his fire plan his own and company team potential target locations and target reference points; his own tank positions and sector; and the site locations of listening or observation posts, obstacles, and early warning devices, as appropriate.

The platoon leader next visits each tank commander in turn in task 6.10. The platoon leader notes the other tanks' positions and sectors in tasks 6.11-6.12. Each tank commander points out potential target areas and desirable target reference points in his own sector, and the platoon leader notes those he decides should be included on the fire plan in tasks 6.13-6.15. The platoon leader then points out platoon and company team potential target areas and target reference points in the tank commander's sector, and the tank commander marks them on his range card in tasks 6.16-6.17. While preparing the fire plan, the platoon

leader reviews and adjusts it as necesary in tasks 6.18-6.21. When satisfied with the completed fire plan, the platoon leader returns to his own tank station and relays a copy of the plan to company team as required in tasks 6.22-6.24.

G. FURTHER PREPARE FIGHTING POSITIONS

The completion of the fire plan, fighting position preparation, and obstacle employment in subphases 4 - 6 gives way to other activities. The further preparation of fighting positions in subphase 7, figure E-13, is an extension of subphase 4. This phase consists of three task groupings. In task 7.1, the tank commander decides if improving position cover is necessary. If so, the appointed crewmen secure pioneer tools and move to the sites needing work in tasks 7.2-7.4. The crewmen complete the pick and shovel work at all designated sites and return to their tank stations in tasks 7.5-7.7. The second task group, tasks 7.8-7.14, are identical to tasks 7.1-7.7, except the digging or other work is directed toward leveling fighting position floors. A level weapons platform improves cannon precision by reducing cant. The third task series, clearing fields of fire, improves observation and denies concealment to the enemy. If the platoon leader decides clearing fields of fire might be profitable, he exercises his chain of command in tasks 7.15-7.16. The work party members move to the

work locations, clear vegetation or raze buildings, and return to their stations in tasks 7.17-7.20.

H. PREPARE SUPPLEMENTARY POSITIONS

If supplementary positions are selected, they also need preparation in subphase 8, figure E-14. Supplementary positions for the tanks cover secondary avenues of approach through the platoon battle position. While the crews prepare their supplementary fighting positions, the platoon leader prepares a fire plan organizing the supplementary positions. The platoon leader may dispatch tanks individually or by section to prepare the positions. Whether echeloned individually or by section, the crews perform the latter elements of subphase 2 and subphases 4 and 7 in their entirety. The intent of echelonment is to provide maximum response to the primary avenue of approach into the battle position while meeting a possible time constraint.

I. MARK NEXT BATTLE POSITION

In addition to preparing the presently occupied battle position, the platoon may also fully prepare a second battle position and reconnoiter a third for later occupation. The second prepared future battle position repeats subphases 1 - 8. Reconnaissance and marking of the third battle position is subphase 9, figure E-15. Platoon members

move to the future platoon position by one of three methods. The platoon leader may send the entire light section to mark the position in tasks 9.1-9.2. More desirably, platoon elements travel as part of a company team quartering party. The platoon representatives may travel on company team transportation in tasks 9.3-9.4, or in a platoon tank in tasks 9.5-9.6. In any case, the platoon leader's chief representative, generally his platoon sergeant, makes the same decisions in tasks 9.7, 9.8, 9.12, 9.13 and 9.15 as the platoon leader does in tasks 2.1-2.5, figure E-4. The platoon sergeant also selects routes into the battle position in task 9.10. His party or crew marks all selected routes and positions in tasks 9.9, 9.11, and 9.14. Upon completion of marking the battle position, the chief representative notes the position organization on a map in task 9.16. In tasks 9.17-9.21, the platoon party returns to the platoon in the same fashion as they arrived. If company team conducts a quartering party, company team marks the routes as required, possibly aided by platoon representatives. When the light section travels alone, the platoon sergeant supervises the marking of the inter-battle position route in task 9.22, although the marking may be done either while travelling to the future position or returning to the current one. After return to the currently occupied battle position, the platoon sergeant reports the future position's organization to the platoon leader in task 9.23.

J. CONDUCT SUSTAINING ACTIVITIES

Throughout subphases 3 - 9 of occupying the battle position, the platoon conducts sustaining operations. Subphase 10, figure E-16--E-20, is accomplished during any lull between higher priority activities. There are six major activity streams as shown in figure E-16. The platoon conducts vehicular maintenance, resupply, replacement of personnel and tanks, replacement of vegetation camouflage, personnel maintenance, and rotation of shifts.

In activity stream 10A, figure E-17, the crew inspects their tank in task 10.1. If the crew discovers any major faults, the tank commander determines if the crew can correct the fault in task 10.2. If not, the tank commander informs the platoon leader who informs company team in tasks 10.3-10.4. Company team maintenance elements decide if the tank can be fixed at the platoon battle position. If not, the tank commander informs the platoon leader, and the crew assists in their tank's evacuation in tasks 10.5-10.6. Meanwhile, the platoon leader reexamines his fire plan and adjusts it as necessary in tasks 10.7-10.9. If company team decides the tank can be fixed at the battle position, the tank commander decides if the tank should be moved to its hide position in task 10.10. Any maintenance resulting in noise or requiring work at hull top or higher should be accomplished in the hide position. If the tank commander elects for the hide position, he informs the platoon leader and directs the crew to move the tank into the position in

tasks 10.11-10.13. The crew repairs the tank under company team supervision in task 10.15. If the crew has repaired the tank in the hide position, the tank commander informs the platoon leader and directs crew and tank back into a fighting position in tasks 10.16-10.18.

On the other hand, if the crew alone can fix the tank and does not need or already has repair parts or supplies, they execute tasks 10.10-10.14 and 10.16-10.18. If the crew needs but does not have repair parts or supplies, the tank commander attempts to find a source for the needed items and designates a crewman to secure the needed items in tasks 10.19-10.20. Needed items not in the platoon are requested from company team in tasks 10.21-10.22. Regardless of the source, the designated crewman secures the needed items in tasks 10.23-10.25, and the crew begins the repair process at task 10.10.

Some maintenance needs, such as petroleum products, are usually available when required because of periodic resupply as illustrated by stream 10B, figure E-18. The platoon resupplies through a micro-version of unit or supply point distribution. In the former, company team vehicles move from tank to tank, transferring supplies from directly behind each tank in its fighting position. In the latter, each tank in turn moves to a central supply point.

If company team does not specify the supply distribution mode, the platoon leader selects one based on his perceived tactical situation and battle position terrain and

trafficability in task 10.26. If the tanks are resupplied in position, the platoon leader so informs the resupply elements in task 10.27. The crew rearms, refuels, and reprovisions, as required, in tasks 10.28-10.31. The crew polices any litter and remounts their stations while the tank commander informs the platoon leader of resupply completion in tasks 10.32-10.34.

If resupply takes place at a central location, the platoon leader selects the point and informs company team resupply personnel in tasks 10.35-10.36. If all supplies are not man portable, each tank commander in turn directs his crew in moving their tank into position next to the resupply vehicles in task 10.37-10.39. The crew executes tasks 10.28-10.33. When finished, the crew returns their tank to one of its fighting positions in tasks 10.40-10.41. If all supplies are man portable, movement of tanks is not necessary. The chain of command causes a designated crewman to secure the supplies in tasks 10.42-10.47. The crew then stows the supplies aboard the tank, polices litter, and remounts their stations in tasks 10.48-10.50.

Resupply is not limited to food, fuel and ammunition. If individual replacements arrive, the platoon leader assigns them to a crew, and they move to their assignments in tasks 10.51-10.53, figure E-19. The tank commander of a new crewman assigns him a tank station, and the crew briefs the newcomer on the current tactical situation in tasks 10.54-10.56. If the platoon receives another crew and tank,

the platoon leader fits the new tank into his battle position organization in tasks 10.57-10.60 and revises his fire plan if necessary in tasks 10.67-10.69. Upon receiving a primary fighting position, the new crew sites their tank at the position in tasks 10.61-10.64. The tank commander selects alternate and hide position sites and appoints a mounted sentry in tasks 10.65-10.66. While the mounted sentry performs his duties, the crew carries out subphases 4, 7, 8 and 10.

While a new replacement crew is cutting vegetation for camouflage, the other tank commanders should consider freshening any vegetation used to camouflage their own tanks and positions in task 10.70 of stream 10D. If any vegetation needs replacing, a designated crewman secures fresh camouflage and replaces the wilted in tasks 10.71-10.75. The crewman carefully conceals or covers used vegetation before remounting his station in tasks 10.76-10.77. Wilted camouflage hastily cast aside is as sure an indicator of a unit's presence as wilted vegetation still being used.

Where fresh camouflage may ultimately preserve personnel assets, personnel maintenance, figure E-20, also helps conserve those assets. To keep crewmen healthy, tank commanders strongly encourage crewmen to follow correct field sanitation and personal hygiene procedures in tasks 10.78-10.81. Many studies have shown disease causes a major portion of combat zone casualties. Rigid adherence to

mundane practices, such as washing of hands before eating or wearing of scarf in cold weather, may significantly reduce disease casualties. Each crewman should periodically examine himself for parasites, sores, et cetera, and general health and observe the well-being of his crewmates in tasks 10.82-10.83. Deficiencies should receive immediate attention in tasks 10.84-10.89.

The crewman's alertness, as well as health, depends on food and sleep in proper measure with shift and other duty, as shown in stream 10F. The tank commander determines shifts based on his responsibilities in task 10.90. If he must supply observation or listening post relief, he sends a designated crewman to the post as scheduled in tasks 10.91-10.93. The relief mounts the post in task 10.94 and executes post duties. The relieved returns to his tank station and shift in tasks 10.95-10.96. Other crewmen rotate eating, sleeping, and mounted sentry duty as scheduled in tasks 10.97-10.102.

K. ENGAGE LONG RANGE

All battle position occupation actions stop when the enemy advances within range of fire controlled by the platoon. Subphase 11, figures E-21--E-22, begins the destroy enemy phase. This subphase consists of five major series of activities. The platoon engages the enemy with artillery and mortar fire. The listening or observation post does likewise until the post is vacated. The platoon

leader monitors the situation closely. The platoon maintains communication. The hot loop is deactivated when no longer needed.

The first grouping of tasks, figure E-21, finds the platoon leader monitoring reports in task 11.1. When he decides the enemy is within range of his platoon's tank cannons, he informs company team in tasks 11.2-11.3. If the enemy is already within platoon direct fire range when first acquired, subphase 11 is bypassed. To maintain communication, the tank commanders watch other tanks for visual signals and monitor their radios, responding as required in tasks 11.4-11.8. When radio listening silence is lifted, the hot loop is no longer required. To prevent communication gear damage and possible crew injuries, the wire is unfastened from its terminals in task 11.9. To conserve wire, the wire is taken up and stored in tasks 11.10-11.11.

The purpose of subphase 11 is destroying the enemy, figure E-22. As a target is acquired, it is reported to the platoon leader, who decides if the target should be engaged in tasks 11.12-11.14. If the platoon leader decides not to engage the target, he reports it anyway in task 11.15 to company team who may decide to direct the platoon leader to adjust fire on the target. If the platoon leader decides to engage the target, he requests permission, if necessary, before transmitting a call for fire in tasks 11.16-11.17. Company team may delay target engagement if the parent unit desires an ambush opening to the defense.

One of the platoon elements that may adjust indirect fire is the listening or observation post. In task 11.18 of series 11B, the platoon leader weighs the post's contribution to fire adjustment against the observers' safe return. While the post is operational, the observers acquire and report targets in tasks 11.19-11.20. The post members may decide to abandon the post because of effective fire or loss of communication in task 11.21. In tasks 11.22-11.25, the former observers move back to the monitor tank with the AN/GRA-39 remote unit. Leaving the remote unit at the monitor tank, the crewmen rejoin their crews while their return is reported in tasks 11.26-11.28. If the platoon leader decides to close the post, he informs the post's party in task 11.29. The crewmen secure the remote module and take up the communication wire as they return to the monitor tank in tasks 11.30-11.33. Upon the crewmen's return to the platoon area, tasks 11.25-11.28 are completed.

L. ENGAGE MID RANGE

Once the enemy comes within range of the platoon's tanks, subphase 12 starts, figures E-23--E-24. This subphase consists of the same general activity areas as the previous subphase. In tasks 12.1-12.3, figure E-23, the tank commanders monitor their radios and respond as appropriate. In tasks 12.4-12.6, the platoon leader decides when his platoon is under effective direct fire and reports that development to company team. The platoon leader should

consider his platoon under effective direct fire when the first of his tanks suffers a hit or near miss. The term -- under effective direct fire -- is a specific application of the more widespread term -- decisively engaged. In either case, the intent is to mark the point in time when the platoon's ability to move is severely hampered if not entirely lost. In task 12.7, the hot loop is disconnected. If the listening or observation post is still active, the members are immediately recalled in task 12.8. Having secured the remote module, they move directly back into their own tank stations, and their return is reported in tasks 12.9-12.13.

The primary activity stream 12A, figure E-24, is more intense than its counterpart in the previous subphase. Tasks 12.14-12.19 are identical to tasks 11.12-11.17, figure E-22, with one exception. In task 12.16, the platoon leader chooses among no fire, indirect fire, or direct fire; where in task 11.14, he chooses only between the first two options. As in the previous subphase, company team may also check the platoon's fire initially to execute an armor ambush. If the platoon leader selects and is authorized to use direct fire, he decides which tanks should fire in tasks 12.20-12.21. If only a single tank is to fire, the appropriate crew executes tasks 12.22-12.24. If the tank commanders have previously been given permission to fire, the crews should individually engage the target immediately after its acquisition.

The platoon leader, however, may decide to distribute his platoon's fire through a platoon fire command. In tasks 12.25-12.26, the platoon leader determines and disseminates the platoon fire command. Those crews who are actively engaging a target cease fire to execute the platoon command. Those crews who have not yet acquired the specified platoon target do so in task 12.27. The platoon leader may desire the shock of surprise achieved through every tank simultaneously opening fire. Otherwise the individual crews fire as soon as possible after receipt of the platoon fire command. If the platoon leader wants the platoon to open fire at his command, every tank commander informs the platoon leader when their crew is ready to fire in task 12.28. When all crews are ready, the platoon leader gives the command to open fire in task 12.29. Whether initiating fire simultaneously or individually, every crew executes tasks 12.30-12.31.

M. ENGAGE SHORT RANGE

When the platoon begins receiving effective direct fire, it begins subphase 13, figure E-25. As before, the tank commanders should monitor their radios, responding if necessary in tasks 13.1-13.3. In task 13.4, the platoon leader monitors the enemy's progress. In task 13.5, he requests permission to leave the battle position. If the platoon conducts a nonrestrictive defense, company team will

probably approve the request which causes this subphase to immediately give way to the next.

If the platoon conducts a restrictive defense to retain the battle position, the platoon will continue to fight. The platoon most likely does not need permission to employ all available fire means. Tasks 13.6-13.10 are identical to tasks 12.14-12.16, 12.19, and 12.21, figure E-24. Individual tanks fire at targets in tasks 13.11-13.12 as in tasks 12.22-12.23. Tasks 13.13-13.17 correspond to tasks 12.25-12.27 and 12.30-12.31. Since the enemy is delivering fire on the platoon, surprise through all tanks simultaneously opening fire is not achievable.

N. CONSOLIDATE/MOVE OUT OF BATTLE POSITION

Depending on the company team decision in task 13.5, one of two vastly different courses of action occur in subphase 14, figures E-26--E-28. In one case, if the platoon does not try to retain the battle position, the unit leaves the position, often while under enemy pressure, figure E-26. While the platoon continues to engage the enemy, the platoon leader selects a position behind and overwatching the platoon's present fighting positions in task 14.1. The platoon leader tells the platoon sergeant to move the light section to the overwatch position in task 14.2. Once the light section, at the platoon sergeant's direction, has individually infiltrated to the battle position rear and has moved <u>en masse</u> into the overwatch position, the platoon

leader is informed in tasks 14.3-14.6. The light section provides overwatching fire to the heavy section as required in task 14.7. The heavy section follows suit in tasks 14.8-14.10. If the platoon leader decides the platoon is still under effective direct fire at the overwatch position, the platoon reinitiates the process at task 14.1 When the platoon finally escapes effective engagement, it moves to its next destination. While the platoon is moving out of the battle position, all tank commanders maintain communication in tasks 14.12-14.18.

In the other case, if the platoon attempts to retain the battle position, the platoon carries out three major series of tasks, figure E-27. The first series generally describes the reorganization of the platoon's men and *matériel* and the evacuation of casualties and damaged equipment. In tasks 14.19-14.21, the platoon leader gathers the status of personnel, equipment, and supplies. He reports his unit's status to company team and decides how to make best use of remaining assets in tasks 14.22-14.23. In tasks 14.24-14.28, the platoon consolidates its remaining assets. Ammunition may be moved from an unserviceable tank to an operational tank. Crewmen from an unrepairable tank may be assigned to replace casualties on a serviceable tank. In tasks 14.29-14.32, casualties and non-operational tanks are evacuated.

As the platoon reorganizes, it must regain quickly its ability to defend. The platoon reviews its preparations

and rebuilds its battle position strength as necessary. These actions essentially repeat subphases 3 - 9.

Part of reorganizing the battle position is to clean up the débris of battle, figure E-27. While the platoon recoups its strength, the platoon leader decides in task 14.33 if a police patrol is required. If so, the platoon leader selects dump points and exercises his chain of command to form a police patrol in tasks 14.34-14.35, shown in figure E-28. The patrol sweeps the entire battle position and reports their findings to the platoon leader before returning to their own tanks in tasks 14.36-14.39. The patrol looks for enemy soldiers in tasks 14.40-14.42. Patrol members move enemy dead to a dump point in tasks 14.43-14.45. Live enemy soldiers are placed under guard and receive medical attention as required in task 14.46. The patrol also looks for enemy equipment in tasks 14.47-14.48. Equipment in working order or whose design has not been previously seen is marked for evacuation in task 14.49. Damaged equipment other than vehicles is moved to the dump or marked in tasks 14.50-14.54. Damaged enemy vehicles may also be moved to a dump site, if the platoon leader so decides, in tasks 14.55-14.62.

The fourteen subphases describe in individual crewman level detail how the tank platoon conducts the defense of a preselected battle position. Given the framework of the

model, platoon measures of performance can be developed in context. The next chapter analyzes subphase 1 to demonstrate the methodology.

V. SAMPLE MEASURES OF PERFORMANCE

To provide a sample of possible measures of performance and potentially influential factors of the tank platoon in the defense is the goal of this chapter. The proposed measures are intended to be made in context of a given subphase or component stream of tasks, subject to the possible factors. Close scrutiny of Refs. 3, 5 - 13, 19, 21 - 27, 29, 31, and 33 - 36 and the author's armor experience cast each task definition. Each task is analyzed in context for potentially relevant factors and feasible measures of task performance.

The factors generally fall into the categories of environment, personnel, and equipment. Environment factors include terrain characteristics, vegetation, visibility, ranges, and atmospheric conditions. Terrain characteristics include terrain features, soil types, and grades. Visibility can be affected by time of day and precipitation. Atmospheric conditions include wind, humidity, electrical interference and temperature. Personnel factors include time since last training, focus of a crewman's attention, verbal skills, and acceptable risk based on perceived tactical situation. Equipment factors include the equipment's type, age, engineering specifications, presence, and operability. Factors may be judged quantifiable or unquantifiable based on their potential for measurement.

Some potential factors and measures are not addressed due to the model limitations discussed in Chapter 2. The following additional assumptions apply to the partial mission task analysis presented in this chapter. A crewman knows the location of the immediately neighboring tanks to the right and left of his own. That which provides cover also provides concealment. A crewman does not willfully disobey an order. Simultaneous multiple task accomplishment is difficult for most crewmen. Task accomplishment proficiency declines with the passage of time.

Every task is analyzed based on the task description, pertinent factors, and the broader context of platoon operations. The measures and factors are tempered by the model limitations and assumptions. The remainder of this chapter proposes measures and factors for subphase 1, move to the battle position. The sequences used in subphase 1 are analyzed before the subphase as a whole is addressed. The measures and factors developed in this chapter are summarized in Appendix F.

A. DISMOUNTED MOVEMENT SEQUENCE

The performance measures for the dismounted movement sequence, figure D-1, depend on the method of destination designation. The destination can be designated by marked route, by proxy, or physically. The method of designation for a given situation is determined partially by the context

of the larger series of tasks and sequences in which the dismounted movement sequence appears.

The route can be marked to the destination or beyond. The platoon leader may be ordered to occupy a position five kilometers south along a road from his present location. He has a destination designated by a route marked beyond the destination. A crewman may be directed to relieve an observation post member. By following the communication wire to the outpost, the crewman reaches his destination by a route marked to the destination.

Designation by proxy refers either to four or six digit map grid coordinates or to a compass bearing and distance from a given reference point. The latter is essentially polar coordinates. Grid coordinates require a map; polar coordinates require a lensatic compass. The type of coordinates given to a crewman is discernable. The process of selection of the type of coordinates the crewman receives is probably not quantifiable. The crewman may have both map and compass available. He may elect to convert from one type of coordinates to the other. For example, given grid coordinates, the crewman may move to the location under visibility conditions making terrain orientation difficult. In this situation the crewman will probably convert from grid to polar coordinates. A conversion channels his subsequent actions. Here again the method of proxy designation exercised is quantifiable but the selection process, often a matter of personal preference, may be inscrutable.

A physically designated destination, however, is not subject to personal whim. An example is the immediately neighboring tanks to the right and left of the crewman's own tank. A crewman may move to a tank in his platoon beyond the immediately neighboring tanks. If the crewman could not see the tank, he moves to a neighboring tank on the appropriate side of his own. There, the next tank or tank position is physically designated, and the crewman moves to the next tank. The process repeats until the crewman reaches his destination. Hence movement to any tank within the platoon is considered equivalent to movement to an immediately neighboring tank. Another example of a physically designated destination is an obvious terrain feature, such as a stand of trees 100 meters from the crewman's present location.

A less obvious terrain feature at a greater distance may be designated as a destination by proxy of grid coordinates. Task S1 first requires the crewman to orient the map. He next determines his location and his destination on the map and computes the map distance between the points. He then attempts to locate his destination on the ground by visually estimating the map distance in the direction of his destination. These actions depend on training in map use skills. The last action depends on training in range estimation. All actions may also be affected by terrain features, vegetation, and visibility. Potential radial errors arise from determining map locations. Distance determinations

may create linear errors. The direction in which the crewman looks for his destination may result in a deflection error. The crewman may incorrectly decide he can or cannot see his destination. The first mistake may result in a radial error between actual and perceived destination locations. The second mistake may result in the same type of radial error and causes the crewman to select a route on a map. This action may result in a less desirable route being chosen and may increase time to select the map route. Consolidation of all possible errors in task S1 for grid coordinates is proposed. Only the final radial error between actual and perceived destination locations should be measured. Time to accomplish task S1 using grid coordinates could also be measured. The focus of the crewman's attention during task S1 is also important. While completing this task, he cannot do other tasks such as transmitting a message by radio.

Given the other proxy designation, polar coordinates, task S1 first requires the crewman to orient his compass for direction. He then visually estimates the distance on the ground. He next attempts to locate his destination while sighting over the compass. All actions depend on training and may be influenced by terrain features, vegetation, and visibility. The first action also depends on compass error. Deflection errors may arise from the compass, compass orientation, and sighting over the compass. Ground distance determination may result in a linear error. The crewman can

make the same types of mistakes described for grid coordinates. The first mistake may result in the same type of radial error previously discussed. The second mistake may result in a series of radial errors.

The crewman may correctly or incorrectly decide he cannot see his destination. In this case he selects an interim destination in the direction of travel. The crewman moves to the interim destination while estimating the distance to the interim destination by any number of methods. These actions may result in the same deflection and linear errors, or radial error, previously discussed. At the interim destination, the crewman again decides if he can see his final destination. If not, he repeats the process just described until he arrives at the destination in piece-wise fashion. Each iteration of the interim destination process may result in a potential radial error. If the crewman decides he cannot see his destination, correctly or incorrectly, he may make a series of radial errors.

One proposed measure of task S1, given polar coordinates, is the consolidated radial error between actual and perceived destination locations. Time of task accomplishment may also be measured. The focus of the crewman's attention should be recorded. When the crewman moves to a destination using interim destinations, the portion of his movement time devoted to destination determination should be included in the task S1 time measure.

Having completed task S1 or having a physically designated destination, the crewman selects a route. Tasks S2 and S3 differ only in the medium of selection, map or ground. The crewman is admonished to select a route "to maximize ... cover ... concealment", by Refs. 6 and 7. Reducing the possibility of detection and destruction of the crewman by the enemy appears to be the intent. Routes are characterized by terrain features which provide cover, vegetation and visibility which provide concealment, and grades and soil types which determine ease of movement. Training to recognize these characteristics on a map or on the ground may influence the route selection. The perceived tactical situation and a possible movement time constraint, however, confound the selection process. Consider the straight line path between location and destination as a baseline. Because of a perceived enemy situation, the crewman may opt for a circuitous route offering better concealment than the baseline. Based on a time constraint, however, the crewman may choose the baseline rather than a less direct, but better concealed, route. The subjective weighing of route characteristics and other factors is acceptable risk, which is probably not quantifiable. Interval measurement of route selection does not appear viable; however, training may influence ordinal measurement. The focus of the crewman's attention pre-empts other tasks. Task accomplishment time is another measure of performance.

Actual use of the route to reach the destination is task S4. The crewman may or may not reach his specified destination. One task measure may be the error between the crewman's intended destination and his location at the end of movement. Varying terrain features which are clothed in varying vegetation and cloaked in varying degrees of visibility, may affect the potential error.

When the destination is designated by proxy, possible radial error exists between the crewman's perceived destination location and the physical location on the ground selected by the crewman to be his perceived destination. This radial error aggravates the radial error between actual and perceived destination locations developed for task S1. The radial error in task S4 may also be related to the total distance travelled and the amount of deviation from the baseline route created by route selection.

A potential radial error also exists for a physically designated destination. The error for this method is between the actual destination location and the physical location on the ground selected to be the destination location. In this method there is a single measured error; in the proxy methods there are two measured errors. In addition to the environment factors, the error for physical designation may also depend on the distance travelled.

The error inherent in following a route marked beyond the destination is similar to that just described. A potential linear error exists between actual destination

location and the physical location selected to be the destination. The factors for this measure are identical to the factors for a physically designated destination.

There is no apparent error, however, in following a route marked to the destination. The only possible factor that applies to this designation method may be willful disregard for the assigned destination. This factor also applies to the other designation methods. This factor, however, does not appear quantifiable and is beyond the scope of this anaylsis.

Movement requires time, and the time to land navigate to the intended location may also be a measure of task S4. Computing time to complete movement based on a single rate of movement is tempting but may be too highly dependent on environment factors to be viable. Grades, soil types, and density of vegetation along the travelled route may affect the movement rate. The weight of the equipment carried by and the physical stamina of the crewman also potentially impact on his speed. The speed with which the crewman wants to reach his destination can be quantified ordinally. The speed the crewman selects, however, may hinge on a perceived time constraint which may not be quantifiable. The crewman's use of available concealment along the route may depend on acceptable risk as discussed later. Acceptable risk, however, also influences task accomplishment time. Part of the movement time may be due to the polar coordinate interim destination process. This S1 task time, however, is

also a part of the S4 task time. Movement time should be a sum of times. Each partial time is a function of the above factors and is computed for each change in any of the factors.

While the crewman is moving, he is subject to acquisition and interdiction by the enemy. Computing some probability of detection based on a single average area projected from the unconcealed portion of the crewman's body and the equipment he carries is also tempting. The projected area may depend on the thickness and height of vegetation and terrain features such as a ditch or sunken road. The areas may also depend on how well the crewman uses the available concealment along the travelled route, based on training and acceptable risk. Given a portion of the route offering only knee high grass, the crewman may use the low crawl to increase his concealment. Because of a perceived time constraint or bulk of equipment carried, the crewman may run through the open area. The latter choice decreases his concealment but also decreases his exposure duration and total travel time. His use of available concealment may be also affected by travelling companions.

Analogous to the unconcealed measure is the uncovered measure. The latter may influence the crewman's successful task accomplishment. The factors for the uncovered projected area are identical to those for the unconcealed area. Certain types of vegetation provide cover, such as the trunk of a tree. As with concealment, the uncovered

area changes as any of the factors change. Hence the duration of each projected area appears as part of the measure.

In addition to the crewman's unconcealed projected area, reflected or emitted light may be a cause of acquisition. Reflected light refers to ambient light reflected by the crewman's skin, clothing, and equipment. The ambient light level may determine the light intensity and may be determined by the route's vegetation. Vegetation and terrain features along the route may mask reflected light. Training may influence the crewman's use of camouflage to reduce reflected light. Emitted light refers primarily to that from lighting a cigarette or using a flashlight. Discipline through training affects both. The crewman may need to use a flashlight, however, to read a map, to recharge a compass luminous dial, or to signal. The selective use of terrain features, vegetation, clothing and equipment, and the crewman's body can mask emitted light. Training affects the crewman's desire and ability to use masking. If the crewman is travelling with or close to others, potential correction of reflected or emitted light indiscipline exists. Their training may influence their recognition and correction of excessive light.

Another means of acquisition is by noise. Movement over dry leaves or through thick dry brush may result in more noise than movement over wet grass. Time since last training may influence where and how the crewman steps while

negotiating his selected route. His desired rate of movement may influence his decision. Loosely secured equipment carried is another source. Voice levels while speaking may add to movement noise. All sources are influenced by training. As with light, the presence of other nearby crewmen and their state of training may influence the traveller's lack of noise discipline.

The last facet of the movement sequence bearing consideration is repeated movement to the same destination. Repeated travel probably reinforces the destination's perceived physical location and route selection, if the crewman remembers the previous destination. The only measure possibly influenced is travel time given the same set of factor values. Travel time may decrease slightly. Movement to the same destination by a different route because of a different starting point would depend on the new route's characteristics only.

B. MOUNTED MOVEMENT SEQUENCE

Most of the preceding analysis also applies to the mounted movement sequence, figure D-1. Again, the five distinct methods of destination designation exist. Initiating the sequence, task S5, like task S1, applies only to proxy methods. The recommended measures and applicable factors for task S5 are identical to task S1. The decision made in task S5 is based on the same criteria as task S1 and leads to the same decision exercised in tasks S6 or S7.

Tasks S6 and S7, like tasks S2 and S3, apply to destinations designated physically and by proxy. Tasks S6 and S7 differ from their counterparts only because the former require selection of a route for a tank. The same measures and factors derived for tasks S2 and S3 also apply to tasks S6 and S7.

Task S8, like task S4, applies to all methods of destination designation. The measures for task S8 change only in that they now apply to a tank. The factors change for the same reason. The vegetation factor of task accomplishment time for task S4 does not apply to mounted movement. Ground pressure is that of a combat loaded tank. The physical stamina is replaced by tank transmission torque output. Although the trunk of a large tree provides cover for dismounted movement, vegetation does not provide cover for a tank. In measuring the intensity and wavelength of emitted noise, the additional factors of soil types; grades; engine type, age, and speed; and suspension component type and age may be influential. Tank engine noise may range from a roar or rumble to a whine depending on engine characteristics and load. The suspension system, including track, generally emits a chirping noise when the tank is moving. The suspension system may also emit a clunking noise when direction is changed rapidly. Time since last training may influence the driver's tendency to change direction suddenly while moving or to race the engine during momentary halts. Likewise, time since last training of the

other crew members may also influence suppression of the driver's bad driving habits.

Land navigation is partially dependent on the interaction between the tank commander and driver. In task S9, the tank commander gives speed and destination or direction instructions to the driver _via_ intercom. Time spent in task accomplishment may depend on the time since the tank commander and driver trained together. Barring that, the task may depend on time since last training for each. Other quantifiable factors may include terrain features, vegetation, and visibility. The unquantifiable factor of verbal skills and understanding may also influence task accomplishment. A potential measure is total time the tank commander spends directing the driver during movement. The status or focus of attention of the tank commander may also be important. While the tank commander is directing the driver, the tank commander's attention in his sector of observation may be reduced or eliminated.

The driver must respond to the tank commander's directions. While monitoring gauges and warning lights in task S10, the driver must physically operate the tank including stopping and starting the tank engine. The factor of time since last training with the tank commander may affect the driver's ability. Barring training with the tank commander, time since the driver's last training may be influential. Because intercom provides an immediate feedback capability, no error between the tank commander's instructions and

driver's execution merits consideration. Verbal skills and understanding, however, may affect the task. A potential measure is the driver's response time to the tank commander's instructions. This time appears as part of the travel time determined in task S8.

The driver can operate the tank using certain practices which tend to reduce exhaust and dust signatures. Time since the driver's last training may be influential. Terrain features and vegetation conceal the signatures somewhat. Dry soil types usually result in a noticeable dust signature. Wet soil types through poor traction may cause the engine to labor resulting in a heavier exhaust. Grades have the same effect as wet soil types. Higher engine speed results in more exhaust. Older engines may burn more engine lubricant which causes a heavier exhaust. The rate of movement desired by the tank commander indirectly influences engine speed in that the driver selects the gear for the transmission and, hence, engine speed and load. Wind and humidity may also affect the size or particle density of the signature. Each type of signature could be measured as a projected area of the unconcealed portion of the signature and a particle size and density. A change in any of the factor values may result in a change in the measurement. Hence, duration of any given set of factor values should be part of the measure.

C. SECTION MOVEMENT SEQUENCE

The tank commander land navigates eventually to a place, a physical location on the ground. As the tank and crew near the destination, the tank commander selects a site where the driver will stop the tank, figure D-1. In task S14, the tank commander is trained to select a firing position site that "provides cover, concealment, maximum fields of fire, ... covered and concealed routes into and out of the position"; is "below the crest and preferably on the sides of a hill ... avoid swampy areas and hillsides ... are dry and level"; and are not "near or within prominent terrain features," according to Ref. 5. The apparent anomoly makes a subjective decision more difficult. This task is similar to task S6, route selection, and includes it. The location and nature of terrain features help describe cover, concealment, the field of fire, and routes. The location and nature of vegetation help describe the latter three also. Soil type and grade describe and limit routes. All may limit potential fighting position sites. Poor visibility may cause a tank commander to sacrifice some concealment for a better field of fire. A time constraint may force the tank commander to accept the first fighting position site found. Compromises among factors introduce the unquantifiable factor of acceptable risk. From this subjectivity, an ordinal ranking of given prospective fighting position sites appears to be a viable measure. The time to make the

decision and the focus of the tank commander's attention also help describe task S14.

After site selection, the crew must place the tank in the fighting position site, task S15. Movement between the point of site selection and the site is considered part of the mounted movement sequence to the site. The crew's actions depend on the method used to define the site. The site may be unmarked, marked, or staked for range card use. The applicable site definition method should be apparent from the context of the larger series of tasks or sequences in which task S15 appears.

For an unmarked site the driver positions the tank in response to instructions from the loader or gunner. The loader, sighting through the opened breech and cannon barrel, directs the driver to stop the tank when mask clearance is achieved. The gunner, looking through his sight, similarly directs the driver. The tank commander's choice of loader or gunner to direct the driver depends on unit standard operating procedure and the presence of a round in the cannon.

A site can be marked using a variety of techniques and materials. Depending on the marking, the driver and any combination of the loader, gunner, and tank commander may assist in siting the tank. The type of marking may or may not require a member of the crew to dismount, ground guide the tank into position, and remount. Since the site is

marked after being occupied at least once, mask clearance may or may not be checked.

The previous discussion also applies to occupying a site staked for range card use. Additionally, markings or stakes outside the site may also be used. These require the gunner to use his sight and reset the azimuth indicator. The stakes may support filtered or shaded light sources which in poor visibility may require a crewman to dismount, operate the lights to site the tank, and remount. This crewman may be the same who ground guides the tank.

Given the site definition method, time to complete task S15 may be a measure along with the attention focus of participating crewmen. Because siting a tank requires precise tank movement, the factors of soil type, grade, tank ground pressure, and transmission torque may influence the time. Time since last training may influence the driver's efficiency in controlling the tank. Time since last training may also influence the other crewmen's performance. Alternatively, time since last crew training may be a factor. The amount and type of marking and staking may affect task accomplishment time. Poor visibility may make the marking harder to see and may increase completion time. Task execution time may also be affected by the perceived time to do the task. The compromise between thoroughness and a time contraint surfaces as acceptable risk. The crewman that does each activity is discernable, but the activity

assignment selection by the tank commander does not appear quantifiable.

Another measure that applies to all site definition methods is the amount of mask clearance present when task S15 is completed. Without mask clearance, the tank's fire is potentially ineffective and dangerous to the tank and crew. The lack of mask clearance should become obvious when the first cannon round is fired, and the crew may take corrective action. The masked round impact, however, might also be mistaken as enemy fire. The amount of mask clearance depends on terrain features and vegetation immediately in front of the tank. If the gunner is checking mask clearance, a potential elevation error exists between sight and cannon. If the loader is checking mask clearance, visibilty may affect his ability to accomplish the task. If the site is marked or staked, the crew may not recheck mask clearance when reoccupying the position. Here the amount, material, and technique of marking and staking may influence the measure. Visibility affects the efficient, and possibly effective, use of the marking or staking. Also, the driver's precision in aligning the tank with the marking or staking affects mask clearance and depends on the same factors previously discussed. The precision and efficiency of a crewman ground guiding the tank may affect the measure. The precision with which the gunner acts may be influential. These factors may depend on time since last training.

Acceptable risk in terms of a perceived time contraint may proscribe a mask clearance check.

Three additional measures may be useful when reoccupying a marked or staked site. The first measure is the radial error between desired and actual tank center of mass. The second is the deflection error between desired and actual hull orientation. Errors of both types may change the tank's unconcealed and uncovered projected areas and degrade range card data. The last measure is the deflection error between desired and actual turret orientation. An error of the last type may degrade range card data. All of these measures depend on the factors of time since last training; soil type; grade; ground pressure; transmission torque; visibility; the amount, material, and technique of marking or staking; acceptable risk; and activity delegation. These factors are important for the same reasons as developed for task accomplishment time and mask clearance. The last type of error also depends on the azimuth indicator deflection error as a function of the equipment and its use by the gunner.

The siting of a tank in a fighting position in relation to the cover and concealment afforded by the site affects the tank's unconcealed and uncovered projected areas. These two measures for task S15 depend on the terrain features and vegetation which define the site as in task S8. The projected areas may change every time the tank is moved from and then back into the fighting position.

Once the tank is in position, there are two other measures, besides projected areas, which affect the tank's potential acquisition by the enemy. Like land navigation, measures of the light and noise intensities, wavelengths, and durations are proposed. Except for the movement mode, the measurement pertaining to light is based on the same factors for the same reasons as in task S8.

The measurement of noise is based on time since last training; tank engine type, age, and speed; and the presence of other nearby crewmen. The factors depend on slightly different reasons, however, than those for the same factors in task S8. While the tank is in the fighting position, operating the tank engine periodically to recharge batteries is necessary. Here training discipline may affect the driver's operation of the engine at the correct speed for the minimum possible time. While the tank is in the site, crewmen should exercise caution in opening and closing hatches and equipment access doors and in performance of maintenance or resupply in the fighting position. These activities become noisy by not adhering to noise discipline gained in training. The presence of other nearby crewmen may be a self-correcting feature of this measure. Acceptable risk may govern the choice of activities and of the degree of noise discipline followed. Because the tank is not moving, the other factors developed for the similar measure in task S8 do not apply.

Since one of the activities is engine operation, the projected area of engine exhaust may also influence acquisition by the enemy. As in task S10, the projected area of the unconcealed portion of the exhaust signature, particle size and density, and duration are proposed as measures. The factors of time since last training; terrain features; vegetation; engine type, age, and speed; and atmospheric conditions affect these measures in the same way as the measures developed for task S10. The presence of other nearby crewmen may also influence the driver's activity. These measures and factors are incorporated into task S10.

D. TRANSMIT MESSAGE SEQUENCE

The efficient and effective control of tanks within a section depends on efficient and effective communication. The transmit message sequence, figure D-2, is found throughout the model. To initiate the sequence in task S16, the tank commander decides if the message requires physical delivery. To transmit a hasty minefield diagram to the platoon leader, the tank commander should probably use physical delivery. To transmit a platoon fire plan to company team, the platoon leader should select physical delivery means. Other messages requiring physical delivery include operations and some other types of tactical orders. The nature of the message affects the task. Time since last training may also affect the sender's decision. Potential measures may be the time to make the decision and the

proportion of times physical delivery is chosen. Here again the tank commander's focus of attention is diverted from other tasks.

If the tank commander selects physical delivery, he must decide either to send a messenger or to move his tank to the addressee, task S17. The factors of distance, visibility, terrain, vegetation, time since last training, and acceptable risk govern this decision. Generally a messenger is not chosen while the platoon is moving. When the platoon is in a static position, a messenger would probably be chosen most often. If the transmission distance is too great, a messenger may not be practical. The danger of interdiction of the messenger may be high because of nearby enemy fire impact. This situation may be offset by poor visibility and good cover and concealment along the messenger's intended route. The weighing of these factors is couched in acceptable risk and may be influenced by time since last training. The time for task accomplishment and the proportion of times each transmission means is selected are potential measures. The focus of the tank commander's attention can also be recorded.

The tank commander may choose to send a messenger. Task S18, however, applies to the designaton of any crewman by any other crewman to execute a task. In task S18, the designated crewman is given action to be completed, destination, and other instructions as appropriate from the context of this task. The instructions can be misunderstood.

This function of verbal skills and understanding does not appear quantifiable. Errors of this type may be potentially self-correcting in the larger context in which this task appears. The only viable measure of this task may be the time of completion and the attention focus of crewman and tank commander.

After the crewman has moved to his destination, he delivers the message, task S20. Task execution depends on the crewman's survival during movement. The only potential measure is task accomplishment time accompanied by the participants' focus of attention. The medium of the message, oral or written, and verbal skills and understanding, if the message is oral, may influence the measure.

After delivering the message and movement back to his own tank, the crewman mounts his own tank station. Task S22, like task S20, depends on the crewman's survival during transit. This task is general and applies to any crewman who has just finished some directed activity outside of his tank. This task exercises the general admonishment to minimize movement in the battle position. The crewman would not remount after finishing a task if he is immediately directed to complete another task requiring his presence outside of his tank. If the crewman has no additional jobs, the proportion of times task S22 is not immediately executed could be measured. This defect is potentially correctable by the presence of other nearby crewmen. The time duration of the delay to remount could also be measured. During this

interval the same unconcealed and uncovered area measures developed for land navigation would apply. An additional factor for both area measures is the location of the tank which provides cover and concealment. Time since last training would affect the proportion and time measures through discipline of the returning crewman and other nearby crewmen. Acceptable risk also affects the crewman's impetus to immediately remount.

Rather than a messenger, the tank commander may elect to deliver the message by tank. Task S24 is identical to task S20 previously analyzed. Task S26 is similar to task S22 but is even more general. No measures are proposed for task S26 because of the large array of possibilities.

If a physical transmission is not selected, the message sender should consider the use of visual signals, task S27. Many factors may influence the sender's decision. Terrain features, vegetation, and poor visibility may mask the intended addressee. Although the addressee is visible, the range may be too great to effectively use visual signals. In addition to environmental conditions, the apparent focus of the addressee's attention may be important. The choice may be affected by the presence of nearby enemy fire impact or other circumstances manifested in acceptable risk. The decision may be influenced by perceived message complexity, another unquantifiable factor. Time since last training may affect the weighing of these factors. Decision time could be measured, and attention focus could be recorded. All

factors may also affect the proportion of times visual signals, by type, are deemed viable.

If the tank commander decides visual signals are viable, he will send his message by visual signals, task S28. If the tank commander decides visual signals are not viable, he may send his message by wire or radio communications, tasks S29 or S30. These three tasks will be discussed concurrently because of their similarities. A measure for all tasks is the amount of time to send the message. The focus of the tank commander's attention is also important. Affecting all tasks is distance to the addressee. Longer distances degrade visual and electronic signals which may cause the message not to be received or may cause the message to be repeated. The addressee may not be observing in the sender's direction or monitoring his radio. Hence the addressee's response time may also be critical. Perceived message complexity may also influence time, but this factor may not be quantifiable. Message transmission in the three tasks involves the use of equipment except for hand and arm signals, of signalling procedures, and of codes. These requirements may effect the efficiency of message transmission and may be influenced by time since last training.

Time is also affected by factors peculiar to each task. Because visual and radio communications depend on line of sight, they are influenced by terrain features and vegetation. Visual signal time may also depend on the type

of visual signal used. Visibility may affect visual signal time. The efficiency of flashlight signals may depend on the intensity and wavelength of the light color used. Similarly, the efficiency of radio communications may depend on the type and age of the radio system used, signal intensity and wavelength, and atmospheric conditions.

Several additional measures unique to the transmission means used are based on the above factors. If the tank commander is using a flashlight, the light signature is important. If radio communications are used, the electronic signature could also be measured. Both measures may influence enemy acquisition of the message sender. Both measures are also factors for the measure of time.

During and after message transmission, the tank commander must decide if the message was received, task S31. If the tank commander physically delivers the message by tank, the message is considered received. If a messenger delivers the message, several possibilities exist. If the messenger returns and reports the message delivered, the message is considered delivered. If the messenger returns and reports the message undelivered, the message is considered undelivered. If the tank commander sees the messenger interdicted or if the messenger does not return after a reasonable time period, the tank commander does not know if the message was delivered. The length of time considered reasonable by the tank commander is quantifiable. The selection of that time is probably not quantifiable,

although the selection may be influenced by the same factors developed for the route selection and land navigation tasks.

When visual signals are used, an acknowledgement may or may not be required by unit standard operating procedures. When wire or radio communications are used, an acknowledgment is required by radio-telephone procedures. If the tank commander receives an acknowledgement, he should consider the message delivered. If the message was not acknowledged but required some obvious immediate action visible to the tank commander, he should consider the message received if the activity starts. If the activity does not start, the tank commander should consider the message undelivered. The tank commander's ability to see the activity is affected by the same factors influencing line of sight. If an unacknowledged message requires no obvious immediate activity, or the addressee was not observable, the tank commander does not know if the message was received. The lack of message acknowledgement or observable immediate activity makes the tank commander's decision subjective. Time since the tank commander's last training, especially with his entire parent unit, may influence his decision. The perceived tactical situation or acceptable risk may also influence his decision. The time to make the decision could be measured. The proportion of times the transmission sequence is repeated or finished could also be measured. The tank commander's focus of attention could also be recorded.

If the tank commander decides the message was received, he must then decide if the message is understood, task S32. The unquantifiable factor of verbal skills and understanding influence this task. Time since last training of the tank commander, especially with his parent unit, may also be influential. The line of sight factors previously developed determine his ability to see the action. The nature of the action required by the message helps define task accomplishment. The perceived tactical situation or acceptable risk may also influence his decision. The time to make the decision, attention focus, and the proportion of times the entire sequence is repeated or finished could be measured.

E. RECEIVE MESSAGE SEQUENCE

Communication needs an active recipient as well as a message sender. The receive message sequence, figure D-2, flavors several measurements proposed for the message transmission sequence. Given that the message sender gains the recipient's attention, the recipient decides if he understands the message in task S33. Verbal skills and time since training, especially unit training, may influence this task. Potential measures include the time to make the decision, attention focus, and the proportion of times a positive or negative response is made.

If the recipient thinks he understands the message, he then decides if an answer is required, task S34. As previously described, certain transmission methods require

at least an acknowledgement. The message, however, may also require some information the addressee has. In this case the recipient must also transmit a message using the transmission sequence. Pertinent factors include verbal skills and time since last training. Unit standard operating procedures determine the necessity of an acknowledgement for visual signals. The nature of the message, simple directive or information request, also determines the nature of the response -- simple acknowledgement, immediate compliance, or information delivered. Accomplishment time, attention focus, and the proportion of times a response is transmitted are possible measures of this task.

On the other hand, the recipient may decide he did not understand the message. Under certain circumstances, the addressee exercises the transmit message sequence to gain understanding. Under other circumstances he prepares to imitate his section leader's actions. The measures for task S37 are the proportion of times a message recipient elects to ape his section leader as opposed to transmitting a message for clarification, attention focus, and task time. The only germane factor is time since last individual or unit training.

F. TARGET ACQUISITION SEQUENCE

Execution of the transmit and receive message sequences is often the result of target acquisition, figure D-3. Task

S38 initiates the target acquisition sequence. The crewman observes and listens in his sector of responsibility for activities which may indicate enemy aircraft, vehicles, and personnel. The factors of terrain features and vegetation define the sector and limit the field of observation. The combination of visibility and the possible use of devices which enhance the crewman's ability to see may determine the portion of his sector he can actually see. The devices may include the field binocular, the AN/PVS-5 night vision goggles, any of the tank sights, or none at all. Equipment factors include type used, age, and operating characteristics. The observer's personal visual acuity may also be a factor. A combination of atmospheric conditions and the observer's personal aural acuity also help define his sector limits.

One measure of this task may be the portion of time that the crewman's attention is focused on a given portion of his sector. The general location of a previously identified activity or target may draw the crewman's focus of attention more often than another general area. Terrain features and vegetation such as a draw, treeline, road, or building may also draw the crewman's focus more often than perhaps a wide open, level field. Observation discipline, through time since last training, may affect the crewman's ability not to allow natural centers of attention to draw his focus of attention. The scanning method used by the crewman may also affect his attention focus; however, the method selection

process may not be quantifiable. Time since last training may influence the efficiency and effectiveness of the selected scanning method.

The perceived tactical situation through acceptable risk may also affect the crewman's attention focus. All of the above factors may affect the measure of the portion of time the crewman spends observing out of the time he is supposed to be observing.

The crewman observes in his sector to detect targets. In task S39, the crewman decides if there is some activity in his sector which possibly indicates a potential target. An activity may be the projected area of any moving or stationary aircraft, vehicle, personnel, or animal. An activity may also be light or noise of given intensity and wavelength, smoke, or dust. Light may be due to explosion, weapons firing signature, tracer rounds, fire, reflection from equipment, or electric light source. Noise may be due to explosion, weapons firing signature, or vehicle movement. Smoke may be due to explosion, weapons firing signature, tactical generation, fire, or vehicle exhaust. Dust may be due to explosion, weapons firing signature, atmospheric conditions, or vehicle movement. The activities may be the result of enemy or friendly military operations or may not be due to military operations at all. The additional factors of terrain features; vegetation; visibility; atmospheric conditions; visual acuity; aural acuity; range to activity; and the type, age, and characteristics of vision

enhancement devices, if used, may influence the portion and relative size of the activity the crewman sees. What he looks for may be influenced by time since last training. His decision may be based on a perceived tactical situation generating a degree of acceptable risk. Measures of this task may be the decision time, attention focus, and the proportion of times a given activity is observed.

Given an activity the crewman must decide if the activity is a target, task S40. Measures of this task include the task accomplishment time, attention focus, and the proportion of times the activity is considered a target. The same factors which affect the crewman's ability to detect an activity also affect his decision in task S40 for the same reasons. In task S40, however, the observer must distinguish a potential enemy military target from other activities. The crewman must recognize enemy equipment in a variety of partially concealed orientations under various viewing conditions. He must also discriminate between live and previously destroyed targets. Time since last training may affect these skills.

Last in the sequence, task S41, is passing knowledge of the acquired target to the tank commander, if the observer is not the tank commander. The only measures proposed are the task accomplishment time and the proportion of times the tank commander is informed when appropriate. The unquantifiable factor of verbal skills and understanding may influence the time measure.

The preceding sequences are components of subphase 1, move to the battle position, Figures E-2 and E-3. Subphase 1 clearly relies heavily on the first six tactical sequences which concern moving and communicating while watching and listening for the enemy. The discussion of subphase 1 will cover only those tasks not discussed in the sequences.

G. SUBPHASE 1

In this subphase there are only nineteen new tasks: 1.1, 1.2, 1.4, 1.6, 1.13, 1.15, 1.19-1.25, 1.27, 1.34, 1.35, 1.38, 1.42, and 1.46. These tasks generally deal with platoon movement techniques, platoon and section position selection, and additional communication skills. Tasks 1.4, 1.6, 1.35, and 1.46 will be discussed concurrently because of their similarity. Tasks 1.20 and 1.22 and tasks 1.21 and 1.23 form two more groups.

In task 1.1, the platoon leader must decide if any part of his platoon in under effective fire. He may base his decision on observed or reported tank damage or casualties due to fire. The location of fire impact in relation to his platoon element locations may also influence his decision. Members of the platoon may report the sighting of weapons firing signatures. The possibility of seeing the signatures depends on the line of sight factors already discussed for a number of tasks. The platoon leader's training may influence his ability to distinguish between random harrassment and interdiction fires and directed, controlled, massed

fires against his platoon. His training may influence his ability to distinguish by type among actively delivered aircraft and ground element munitions and passively delivered munitions like mines. His training may influence his weighing of information. His decision is also affected by the amount of risk he is willing to assume in a given perceived tactical situation. The perceived effect that the fire has on the platoon's ability to continue moving to the preselected battle position also influences the platoon leader's decision. The amount of time the platoon leader needs to make the decision, his attention focus, and the proportion of times he perceives his platoon under effective fire could be measures.

If the platoon leader decides his platoon is under active attack, he must decide if the attack is direct fire, indirect fire, or a mixture of the two. As in the previous task, platoon tank damage or casualties, fire impact location, weapons signatures, and line of sight also affect this task for the same reasons. The types of weapons employed against the platoon and the munitions impact effects may influence this task. The platoon leader's training may assist him in recognizing the types of weapons employed against him or in deducing the types from a knowledge of the enemy's tactical doctrine. The same measures proposed for the previous task apply here also.

The platoon being taken under effective fire implies the enemy has seen the platoon first. More desirably, the

platoon finds the enemy first. The platoon leader assigns sectors of observation to each of his tank commanders in task 1.13. Normally the platoon leader opts for redundant all-around observation. His selection of sectors is based on terrain features, vegetation, and visibility -- the line of sight factors. His training may enhance his thoroughness in determining overlapping sectors. His selection is couched in acceptable risk based on a perceived tactical situation. Like firing position selection, interval measurement of the correctness of sector selection may be elusive. An ordinal ranking of sets of sectors may be the only viable measure along with time to make the selection and attention focus.

Like the platoon leader specifies sectors of observation for each tank, each tank commander selects and specifies overlapping sectors of observation for each member of the crew. The sectors manageable for driver and gunner are necessarily restricted because of their fields of view from their stations within the tank. The tank commander and loader have unrestricted vision in all directions while standing in their open hatches. If, however, the tank is under fire, the tank commander and loader position themselves fully within the tank turret, thereby reducing their fields of vision. Acceptable risk affects the tank commander's decision to keep the hatches open while under fire. All the factors developed for task 1.13 also apply to this task, 1.15. The measures are also the same.

No matter how vigilant the platoon members are, a well-concealed enemy lurking in ambush can surprise the platoon. The potentially devastating effects of surprise can be partially offset by the movement technique selected by the platoon leader in task 1.27. The movement techniques and criteria for selection were discussed in the previous chapter. The only quantifiable potential factors are the suspected enemy locations in relation to the platoon's location and the platoon leader's time since last training. His selection may be complicated by a perceived time constraint. Task accomplishment time, attention focus, and the proportion of times a particular movement technique is selected for a given situation could be measured.

The platoon leader's decision in the previous task is subject to change in task 1.19. Changes in the alleged enemy locations and acceptable risk interpreted by the platoon leader's training may result in a different movement technique. Task accomplishment time, attention focus, and the selected technique given a change in the perceived tactical situation could be measured.

The movement technique is selected in response to perceived enemy positions. While the platoon is moving by travelling overwatch or bounding overwatch, the light section provides overwatch to the heavy section. To do this, the platoon sergeant must identify positions from which effective enemy fire could be delivered or directed against the heavy section. In task 1.34, the platoon

sergeant determines the most probable dangerous position. His decision hinges in large part on geographical aspects -- terrain features, vegetation, and visibility. His selection is affected by the enemy's ability to occupy the position based on trafficability -- soil types and grades. His selection should also be determined by knowledge gained in training of how the enemy fights. His selection is colored by acceptable risk based on the perceived tactical situation. His attention is focused on the task at hand. Time is one possible task measure. Like fighting position selection, an ordinal ranking of potential positions is also possible.

In response to the perceived situation, current movement technique, and potential enemy positions, the platoon sergeant may select section positions and the platoon leader may select platoon positions. The only difference between section and platoon positions is the size due to the number of tanks which will eventually occupy the position. Selection of either sized position in tasks 1.4, 1.6, 1.35 and 1.46 is like the selection of an individual tank position. The geographical factors will delimit the fields of fire and determine available cover and concealment for the occupying tanks. The trafficability factors determine ease of movement into and within the position. Good fields of fire, cover and concealment of friendly elements, and trafficability are desirable features. The platoon leader's or sergeant's training allows him to weigh the relevant

factors. Acceptable risk figures in the balancing of amounts of desirable features. Here again are the measures of task accomplishment time, attention focus, and an ordinal ranking of prospective section or platoon positions.

Having selected a position in task 1.35, during movement by travelling overwatch, the platoon sergeant decides if the light section can halt in that position in task 1.38. His primary criterion is not to allow the heavy section to outrun the light section's overwatch. If the heavy section is almost at the potential enemy position selected in task 1.34, then the platoon sergeant cannot allow his section to halt. If the heavy section still has some distance to travel dominated by the potential enemy position, the platoon sergeant can allow his section to halt. His decision is also based on his looking ahead for the next potential enemy position. His original estimation of the degree of threat posed by the potential enemy position may change. Factors related to distances appear appropriate. The distance between the heavy section and the potential enemy position, as well as the heavy section's rate of speed, are important. The distance between sections may also be critical. The platoon sergeant's training, especially with the platoon, may play a role. Acceptable risk based on the perceived tactical situation also sways the platoon sergeant's decision. Task measures may include decision time, attention focus, and proportion of times for a given outcome.

Whether passing through the overwatch position or occupying it briefly during travelling overwatch, the platoon sergeant constantly reevaluates the overwatch position's tenability in task 1.42. His decision of when the position no longer serves its purpose is based on the same factors as for task 1.38. The purpose of this decision is also essentially the same in both tasks 1.42 and 1.38. Hence the same measures are also proposed.

To coordinate movement of the platoon and to relay intelligence, the platoon's tank commanders must maintain communication. The purpose and mechanics of message transmission have already been discussed in the transmit message sequence. Not all mechanics of message receipt have. In tasks 1.20 and 1.22, certain tank commanders observe other tank commanders for visual signals. The platoon sergeant should keep the platoon leader in sight and the non-section leader tank commanders should keep their section leaders in sight. The line of sight factors, however, may occasionally prohibit this requirement. If the tank commanders are already aware they cannot see their leader, they probably will not look again until tank locations change. The time since last training may affect the tank commanders' discipline to keep their leader in sight and periodically glance at the leader for visual signals. The tank commanders' observation is also flavored by the acceptable risk in a perceived tactical situation. Potential measures include the portion of time the tank

commander devotes to watching his section or platoon leader, as appropriate, and the focus of attention for the duration of each glance.

Given that the tank commander is watching for visual signals, he must decide if a message is sent in tasks 1.21 and 1.23. The line of sight factors affects the tasks here like tasks 1.20 and 1.22. Time since individual or unit training may influence the tank commander's detection and recognition of visual signals. The transmission distance and the recipient's visual acuity may also affect message detection. The method of visual signalling used also affects detection. Flag signals are observable at greater ranges than hand and arm signals. If flashlight signals are used, the light wavelength and intensity determines effective range. The proportion of times he sees a given signal could be measured. His attention is focused on the signalling.

Similar to the look-see process of tasks 1.20-1.23 is the listen-hear process of tasks 1.24 and 1.25. Like tasks 1.20 and 1.21, task 1.24 requires each tank commander to monitor the platoon radio net and the platoon leader to monitor the company team command net. Like visual signals, radio signals are also line of sight. Radio signals are also affected by atmospheric conditions. If the tank commander has already lost radio contact, he may not bother to listen until tank positions change. Acceptable risk also influences the tank commander's diligence in closely

monitoring the radio. His discipline in doing so may be influenced by training. The same measures proposed for tasks 1.20 and 1.24 are also proposed for this task.

If the tank commander is listening for radio messages, he must decide if a message is being sent to him in task 1.25. The line of sight factors and atmospheric conditions affects this task like task 1.24. Individual or platoon training may favorably influence the tank commander's ability to recognize a message sent to him, through proficiency in radio-telephone procedures and codes. The tank commander's aural acuity may affect his ability to hear a weak signal. Signal strength can be affected by the distance between sender and recipient. Signal strength may also depend on the signal frequency and intensity and the radio system type and age used by each party. The same measures proposed for tasks 1.21 and 1.23 are also proposed for task 1.25.

The measures and factors developed for all tasks in subphase 1 are summarized at Appendix F. The summarized version of the task analysis does not imply that the measures should be made out of context. Each task should be measured in the context of the platoon activity in which it appears. Many portray combat as unmeasurable because of its infinite array of possibilities. There may be several factors -- leadership, individual morale, unit esprit de corps, acceptable risk, and others -- which presently defy measurement. The model developed in chapters 2 - 4 and

shown in Appendixes D and E does have some simplifying limitations. However, through the type of just demonstrated thorough task analysis within the proposed model framework, measuring combat may be a possibility after all.

VI. APPLICATIONS

The model shows clearly how the tank platoon defends a preselected battle position. The sample task analysis shows how to develop measures of the defending platoon's effectiveness. The model and complete task analysis within the model structure have several potential applications:

- Improve training and doctrine literature
- Improve institutional and unit training
- Improve mission performance measurement
- Improve combat computer simulations

During model development, no one source was found that fully explained how the tank platoon defends a preselected battle position. Although Refs. 3 and 5 - 9 are redundant in many aspects, not one reference is complete. All command echelons from division to company team have a specific field manual written expressly for each level of command. The platoon does not have a single reference which fully explains how to defend. The armor community needs to develop a single field manual for the platoon. The model can be used as a guide for the defend mission in developing a single reference for the platoon. The tacticians must explain how to fight.

The current training and doctrinal literature forms the basis for institutional and unit training. References 5 - 10 show how and why the platoon is trained. The

training is aimed at individuals, crews, and the platoon; but no one training program exercises all individuals together in a cohesive fashion. Currently in individual training, little attention is paid to how individual tasks are aggregated into unit operations. In unit training, little attention is paid to how platoon activities depend on coordinated sequential individual tasks. Individuals must ultimately train in the context of platoon operations. The current approach to individual, crew, and platoon level training shows little interface between echelons. The model and analysis methodology can be applied to the tank platoon defend mission to develop integrated crewman through platoon level training. The schools and units must train how to fight.

Much of the training conducted in the schools and units is without meaningful measure. The scoring systems used in the Skill Qualification Test, Tank Gunnery Tables, and Army Training and Evaluation Program missions is arbitrarily and largely subjectively or ordinally based. The training manager has no way of knowing if his tank platoons are ready to defend. He has no way of determining how much training is required. He has no way of deciding what specific attributes to exercise. He has no way of gauging performance. Task analysis within the model framework presented could reveal an exhaustive list of measures of tank platoon performance. Analysis of data gathered for each measure may show some activities to be insignificant. Other numerical

methods may show some measures can be combined. A reduced list of significant measures of performance is a more meaningful evaluation system for crewman, crew, and platoon defensive actions than currently exists. Training managers must know which performances are critical in measuring platoon performance. Albeit some measures may not be quantifiable, most measures will provide a framework in which to evaluate platoon performance. The training managers must measure how to fight.

Data collected for the list of significant measures can generate meaningful input to the computer simulations of combat, the wargames, and the other models. Of particular interest is the effect of training in realizing equipment potential. The model here provides the framework from which the defense process can be abstracted as necessary in the computer simulations. All significant measures gained through intensive task analysis and data analysis should be incorporated into the new generation of simulations, like STAR. The simulations may then answer all the types of questions posed in Chapter 1. The answers can enhance the basis of information used to make decisions. The combat modellers must assist the decision maker decide how to fight.

The model and analysis methodology have several applications in the study of the tank platoon in the defense. The type of model shown and measures can also be developed for all other platoon missions. Models and

analysis of the other platoon missions have the same applications as developed for the defend mission. All potential uses point toward the common goal of better understanding the art of war. Through better comprehension and measurement, the art may be refined into the science of war.

APPENDIX A

ABBREVIATIONS

ACT	ACTivity (ACTivities)
AFP	Alternate Fighting Position(s)
ASEQ1	Activity SEQuence type 1
ASEQ2	Activity SEQuence type 2
AVA	AVAilable
BOU	BOUnding
BP	Battle Position
BWO	Barbed Wire Obstacle(s)
C	Crewman (Crewmen)
CAM	CAMouflage
CFSEQ	Call for indirect Fire SEQuence
CON	CONceal
COV	COVer
CR	CRew(s)
CT	Company Team
CW	Communication Wire
DEC	DECide if
DEMO	DEMOlitions
DES	DESignate
DEST	DESTroy
DET	DETermine
DF	Direct Fire
DFC	Direct Fire Controls
DMSEQ	Dismounted Movement SEQuence
DR	DRiver(s)
DREC	Dismounted REConnaissance
DSEQ1	Decision SEQuence type 1
DSEQ2	Decision SEQuence type 2
EF	Effective Fire
ELE	ELEment(s)
EN	ENemy
EQU	EQUipment
FC	Fire Command
FF	Field(s) of Fire
FP	Fighting Position(s)
FPSEQ	Fighting Position SEQuence
GU	GUnner(s)
HL	Hot Loop

HMF	Hasty Mine Field(s)
HP	Hide Position(s)
HS	Heavy Section
IF	Indirect Fire
IFC	Initial Fire Command
IT	ITem(s)
LN	Land Navigate
LO	LOader(s)
LOC	LOCation(s)
LOP	Listening or Observation Post
LS	Light Section
ME	MEssenger
MES	MESsage
MMSEQ	Mounted Movement SEQuence
MON	MONitor
MOTS	Mount Own Tank Station
MS	Mounted Sentry (Sentries)
MT	Movement Technique
OBS	OBServe
OO	Other Obstacle(s)
OW	Over Watch
PER	PERsonnel
PFC	Platoon Fire Command
PFP	Primary Fighting Position(s)
PL	Platoon Leader
PLA	PLAtoon
POS	POSition
POT	POTential
PS	Platoon Sergeant
RC	Range Card(s)
RCOM	Radio COMmunication
REC	RECeiver
REP	REPort
REQ	REQuired (by)
RLS	Radio Listening Silence
RMSEQ	Receive Message SEQuence
RO	ROund(s)
SAFP	Supplementary Alternate Fighting Position(s)
SBP	Subsequent Battle Position
SEA	SEArchlight
SEC	SECtion
SECT	SECTor(s)
SEL	SELect
SFC	Subsequent Fire Command
SFP	Supplementary Fighting Position(s)
SHP	Supplementary Hide Position(s)
SL	Section Leader

SMSEQ	Section Movement SEQuence
SPFP	Supplementary Primary Fighting Position(s)
TAR	TARget(s)
TASEQ	Target Acquisition SEQuence
TC	Tank Commander(s)
TESEQ	Target Engagement SEQuence
TF	Trip Flare(s)
TK	TanK(s)
TMSEQ	Transmit Message SEQuence
TRA	TRAvelling
TRP	Target Reference Point(s)
TUR	TURret
UGS	Unattended Ground Sensor(s)
VCOM	Visual signal COMmunication
VEH	VEHicle(s)
WCOM	Wire COMmunication
WEA	WEApon(s)

APPENDIX B

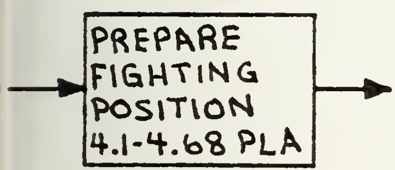
RELATIONS

ɜ	and EX: LOɜGR means loader and gunner
/	or EX: C/TC means crewman or tank commander
$\equiv$	equivalent from left to right EX: crewman $\equiv$ tank commander means that the crewman is the same person as the tank commander
$\not\equiv$	not equivalent from left to right EX: crewman $\not\equiv$ tank commander means that the crewman is not the same person as the tank commander

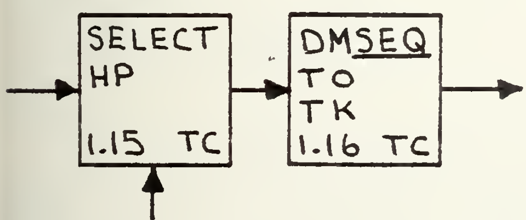
APPENDIX C

FLOW SYMBOLS

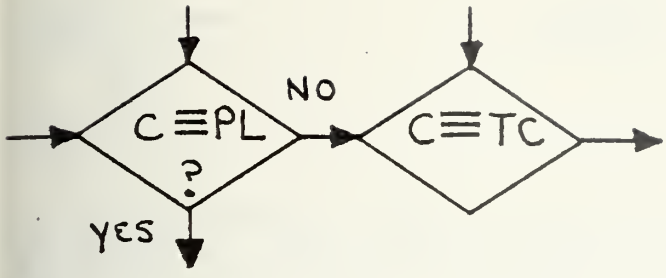
The flow arrow shows the direction or order of tasks.



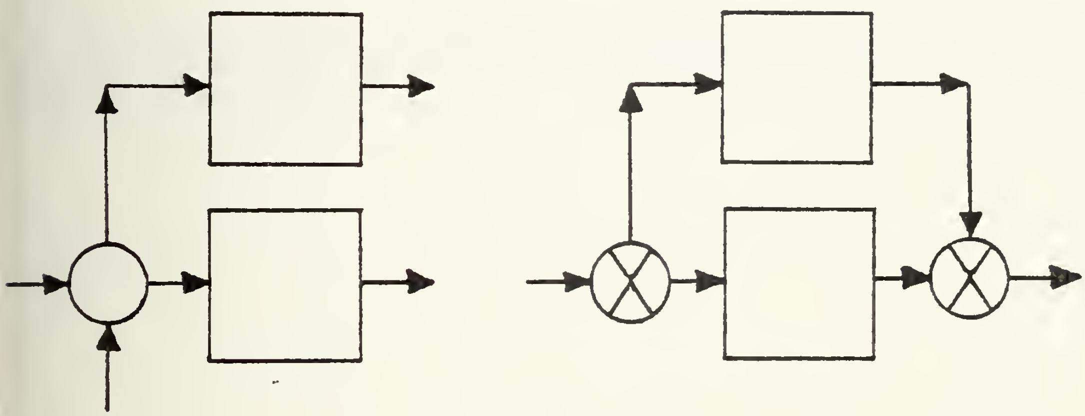
The large process or activity rectangular block denotes a large collection of individual tasks. The arrows indicate the collection's order in a flow of tasks, sequences, or subphases. The numbers in the lower left hand corner correspond to all numbered tasks and sequences in the collection. The entry in the bottom right hand corner is the individual or group of individuals who accomplish the large collection of tasks. Up to three lines of printing describe the major collection of tasks.



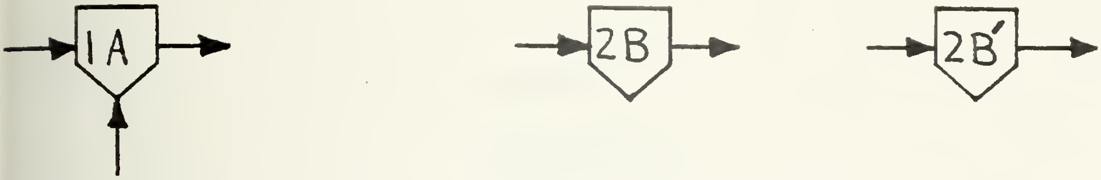
The small process or activity square block symbolizes either a single task or a small collection of tasks -- sequence. In either case, one or more arrows may lead into the block, but only one arrow leaves it. Also, the number in the lower left hand corner identifies the task or sequence. As before, the doer or doers of the task or sequence appear in the lower right hand corner. If the block refers to a single individual task, as on the left, up to three lines describe the task. If the block refers to a sequence of tasks, as on the right, the first line is always the sequence name with the letters SEQ underlined, and up to two additional lines may follow to further define the sequence.



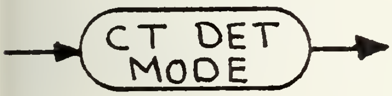
The decision diamond is also used two ways. In either case, one or two arrows may lead into the symbol. Up to three lines describe the relationship. The diamond on the left is standard flow chart practice. The relationship is tested. The test is answered either yes or no with labelled arrows redirecting the flow as appropriate. The diamond on the right is an example of the default in a series of tests. The relationship is established, not tested. Note the lack of a question mark, the lack of exit labelling, and the single exit arrow.



The connector circle is used singly or in pairs. The single circle indicates the simultaneous, or nearly simultaneous, start of two or more parallel series of tasks, sequences or subphases. The parallel activities may be accomplished in an integrated fashion. One or two arrows may lead to the connector. The pair of circles shows the simultaneous start or two or more activities, all of which must reach completion before the activity flow can continue beyond the second connector. In either case, each starting arrow from the initiating connector may lead to a task, sequence, subphase, or a string of any combination of the preceding.



The off-page connector is also used singly or in pairs. The symbol on the left portrays a series of tasks that starts at that point on one page but is shown and ends on a separate page. The connectors on both pages have the same alpha-numeric identification. The number refers to the subphase number. The pair signals a series of tasks that starts on one page, is shown on a separate page, and rejoins the flow on the first page. Again, the identification appears on both pages.



The last symbol is used for administrative comment on activities occurring outside the platoon, usually at the company team level.

APPENDIX D

SEQUENCES

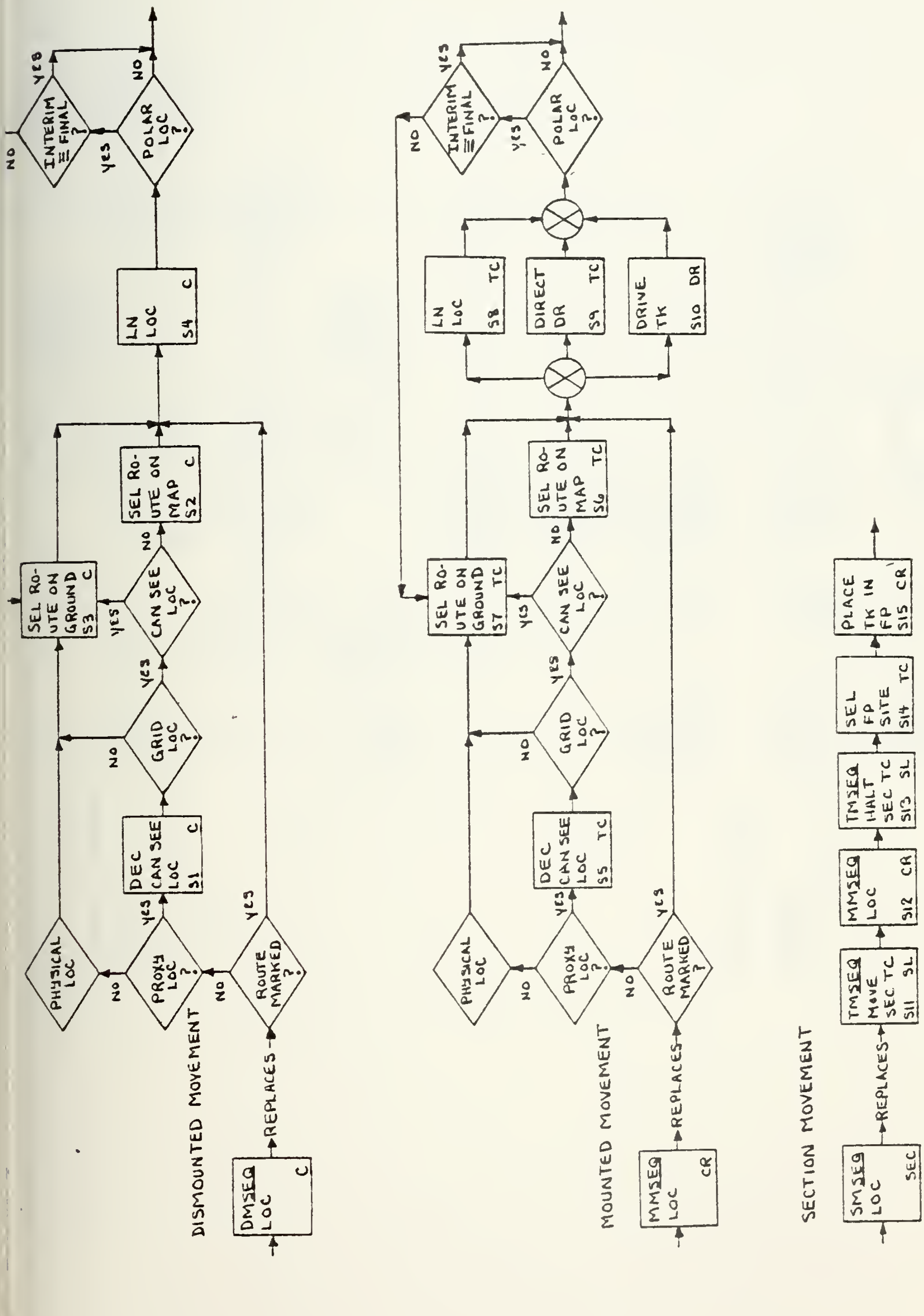


fig D-1

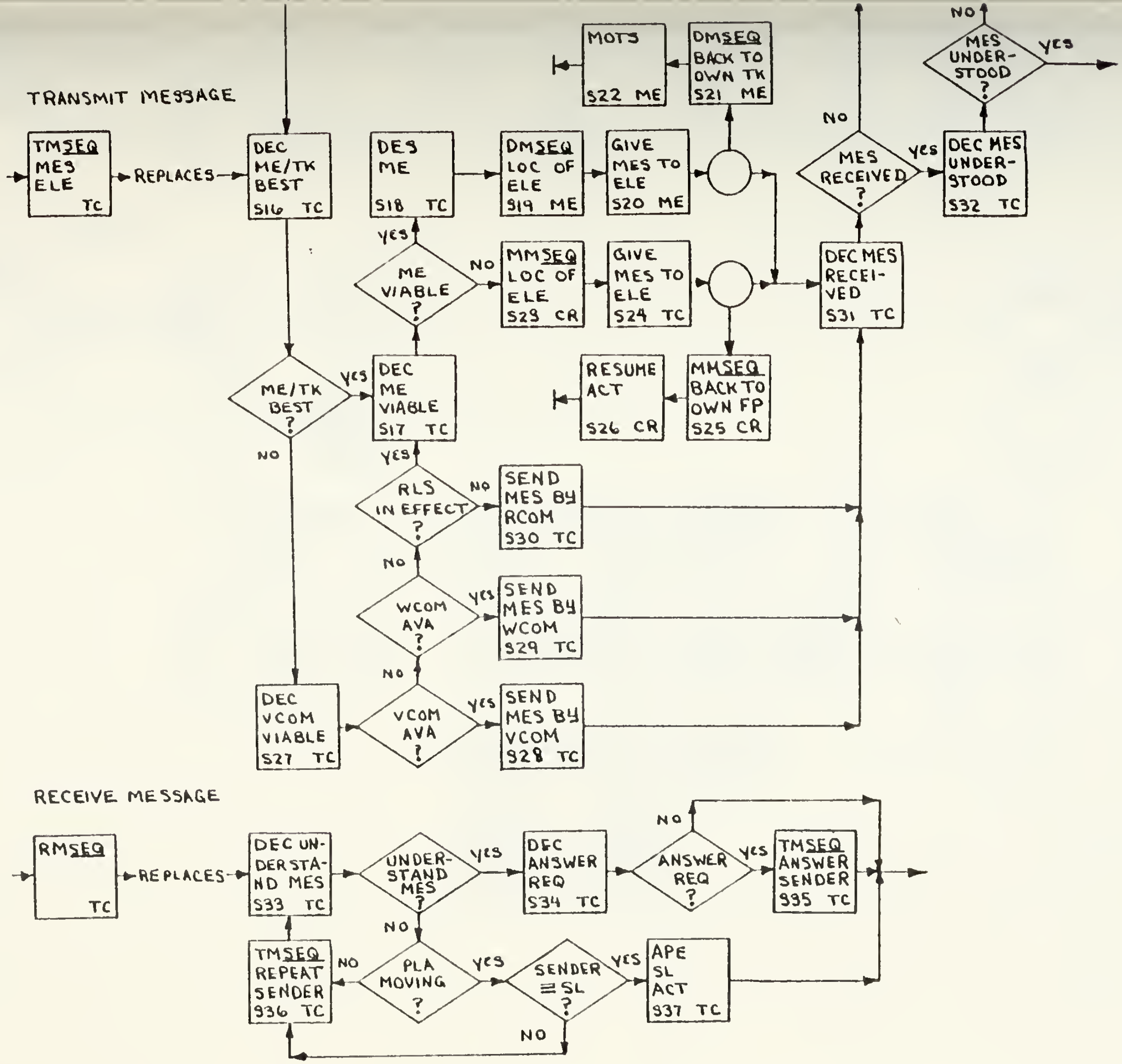

TRANSMIT MESSAGE
TMSEQ MES ELE TC
REPLACES
DEC ME/TK BEST S16 TC
ME/TK BEST ?
YES
NO
DEC ME VIABLE S17 TC
ME VIABLE ?
DES ME S18 TC
DMSEQ LOC OF ELE S19 ME
GIVE MES TO ELE S20 ME
DMSEQ BACK TO OWN TK S21 ME
MOTS S22 ME
MMSEQ LOC OF ELE S23 CR
GIVE MES TO ELE S24 TC
MMSEQ BACK TO OWN FP S25 CR
RESUME ACT S26 CR
DEC VCOM VIABLE S27 TC
VCOM AVA ?
SEND MES BY VCOM S28 TC
WCOM AVA ?
SEND MES BY WCOM S29 TC
RLS IN EFFECT ?
SEND MES BY RCOM S30 TC
DEC MES RECEI-VED S31 TC
MES RECEIVED ?
DEC MES UNDER-STOOD S32 TC
MES UNDER-STOOD ?
RECEIVE MESSAGE
RMSEQ TC
REPLACES
DEC UN-DER STA-ND MES S33 TC
UNDER-STAND MES ?
DEC ANSWER REQ S34 TC
ANSWER REQ ?
TMSEQ ANSWER SENDER S35 TC
PLA MOVING ?
SENDER ≡ SL ?
APE SL ACT S37 TC
TMSEQ REPEAT SENDER S36 TC

Fig D-2

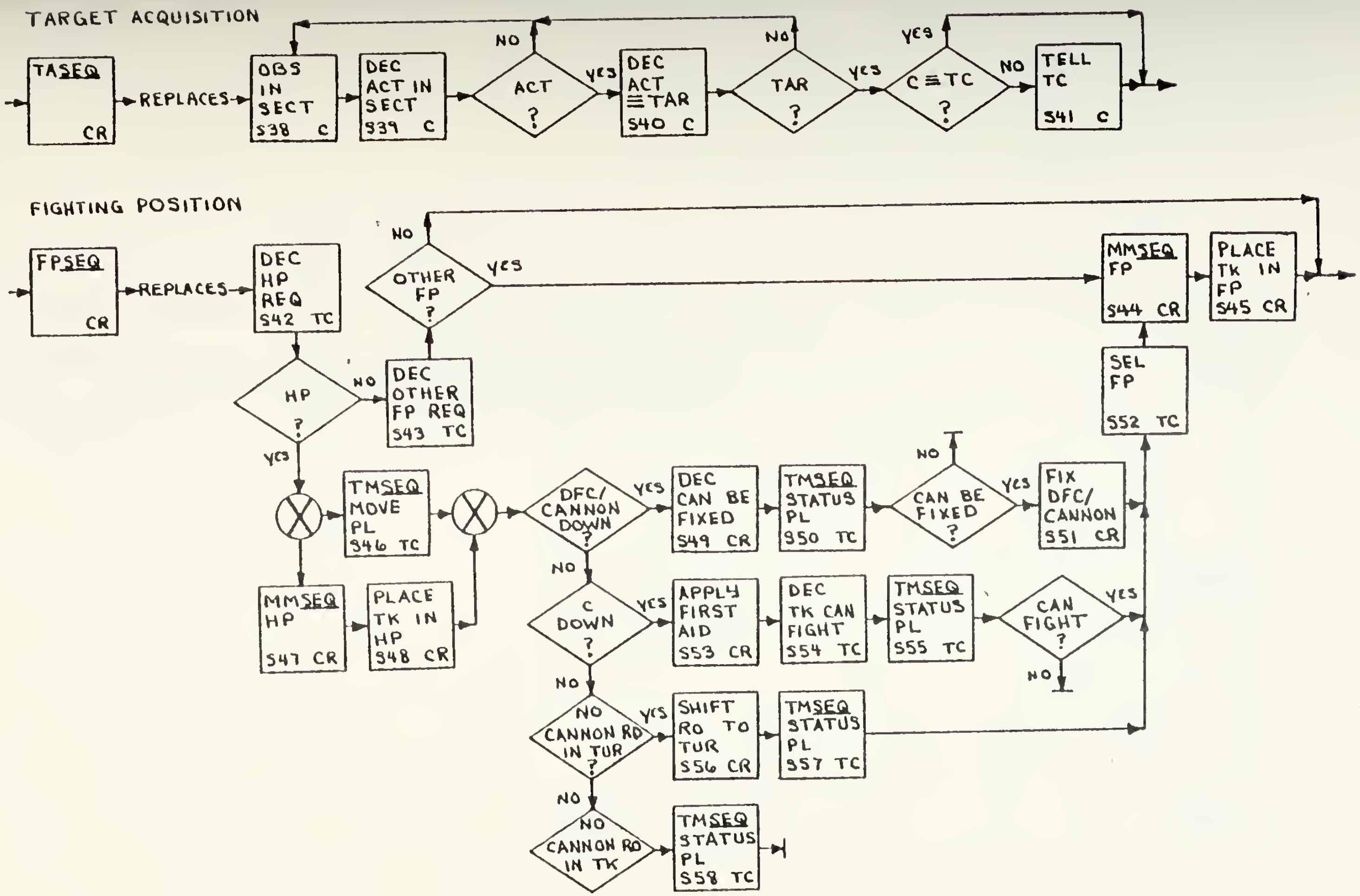

TARGET ACQUISITION
TASEQ CR
REPLACES
OBS IN SECT S38 C
DEC ACT IN SECT S39 C
ACT ?
NO
YES
DEC ACT ≡TAR S40 C
TAR ?
NO
YES
C ≡ TC ?
YES
NO
TELL TC S41 C
FIGHTING POSITION
FPSEQ CR
REPLACES
DEC HP REQ S42 TC
HP ?
NO
YES
DEC OTHER FP REQ S43 TC
OTHER FP ?
NO
YES
MMSEQ FP S44 CR
PLACE TK IN FP S45 CR
SEL FP S52 TC
TMSEQ MOVE PL S46 TC
MMSEQ HP S47 CR
PLACE TK IN HP S48 CR
DFC/ CANNON DOWN ?
YES
NO
DEC CAN BE FIXED S49 CR
TMSEQ STATUS PL S50 TC
CAN BE FIXED ?
NO
YES
FIX DFC/ CANNON S51 CR
C DOWN ?
YES
NO
APPLY FIRST AID S53 CR
DEC TK CAN FIGHT S54 TC
TMSEQ STATUS PL S55 TC
CAN FIGHT ?
YES
NO
NO CANNON RD IN TUR ?
YES
NO
SHIFT RO TO TUR S56 CR
TMSEQ STATUS PL S57 TC
NO CANNON RD IN TK
TMSEQ STATUS PL S58 TC

fig D-3

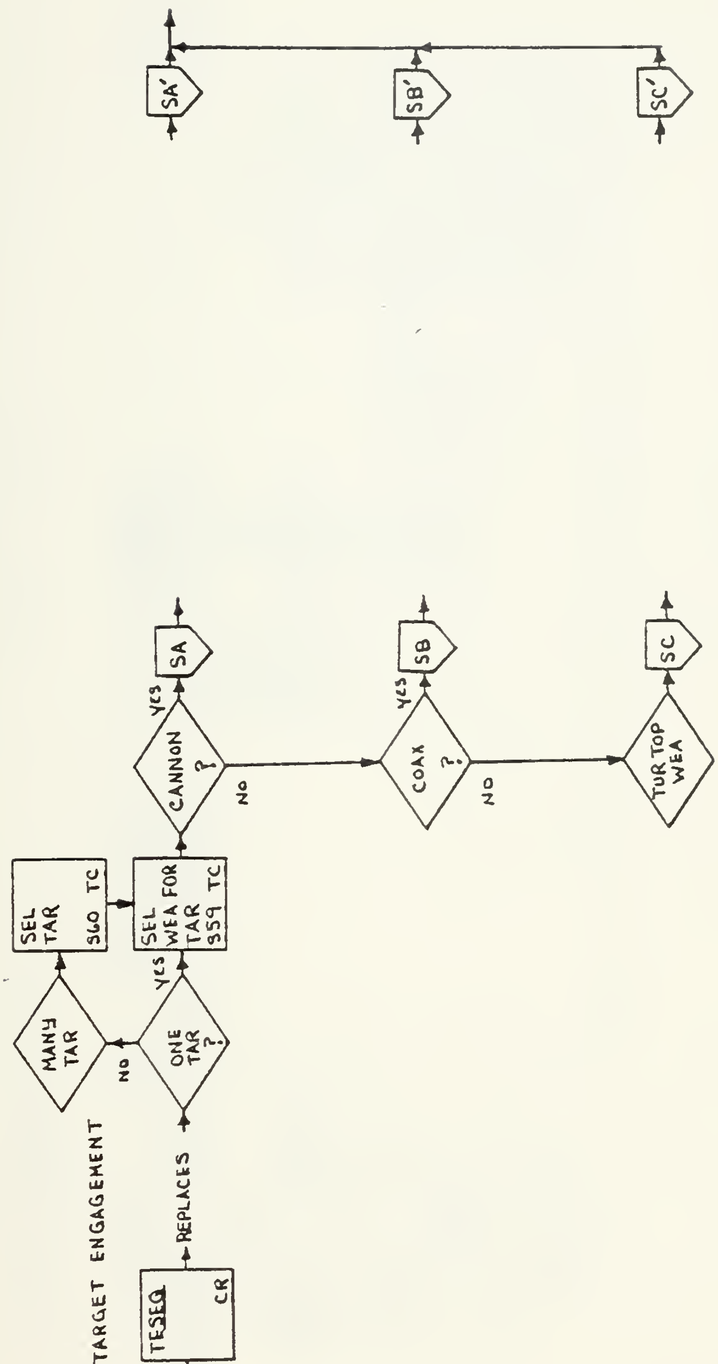

TARGET ENGAGEMENT
TESEQ
CR
REPLACES
ONE TAR ?
NO
MANY TAR
SEL TAR
560 TC
YES
SEL WEA FOR TAR
359 TC
CANNON ?
YES
SA
NO
COAX ?
YES
SB
NO
TUR TOP WEA
SC
SA'
SB'
SC'

Fig D-4

TARGET ENGAGEMENT CONT.

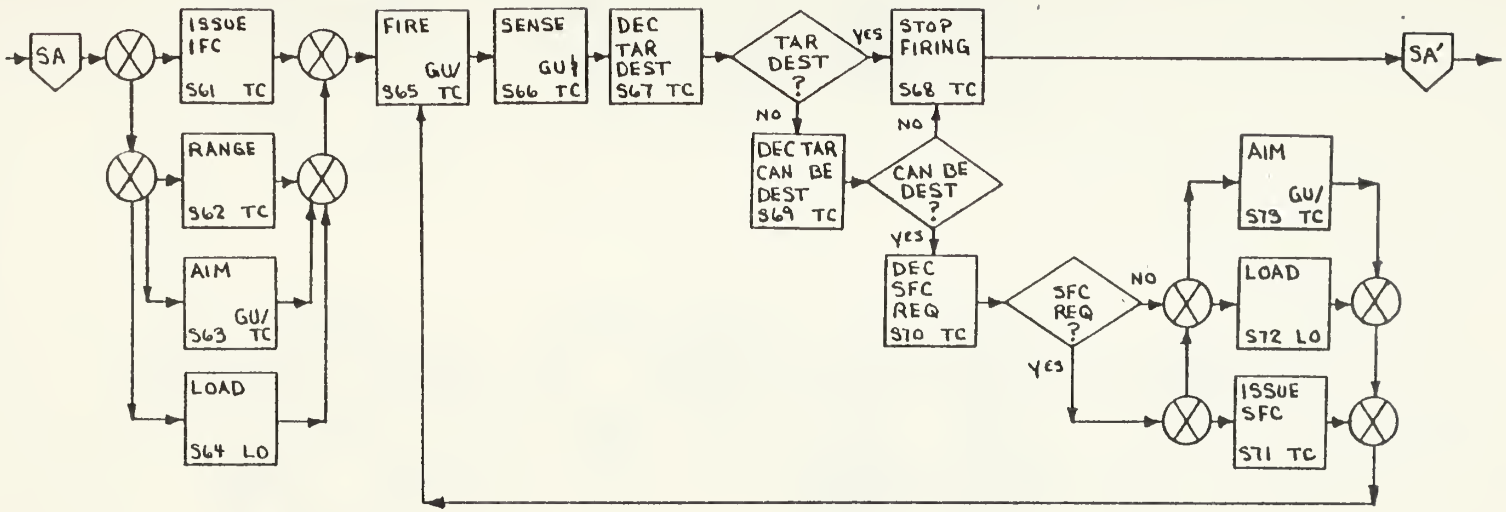


fig D-5

TARGET ENGAGEMENT CONT.

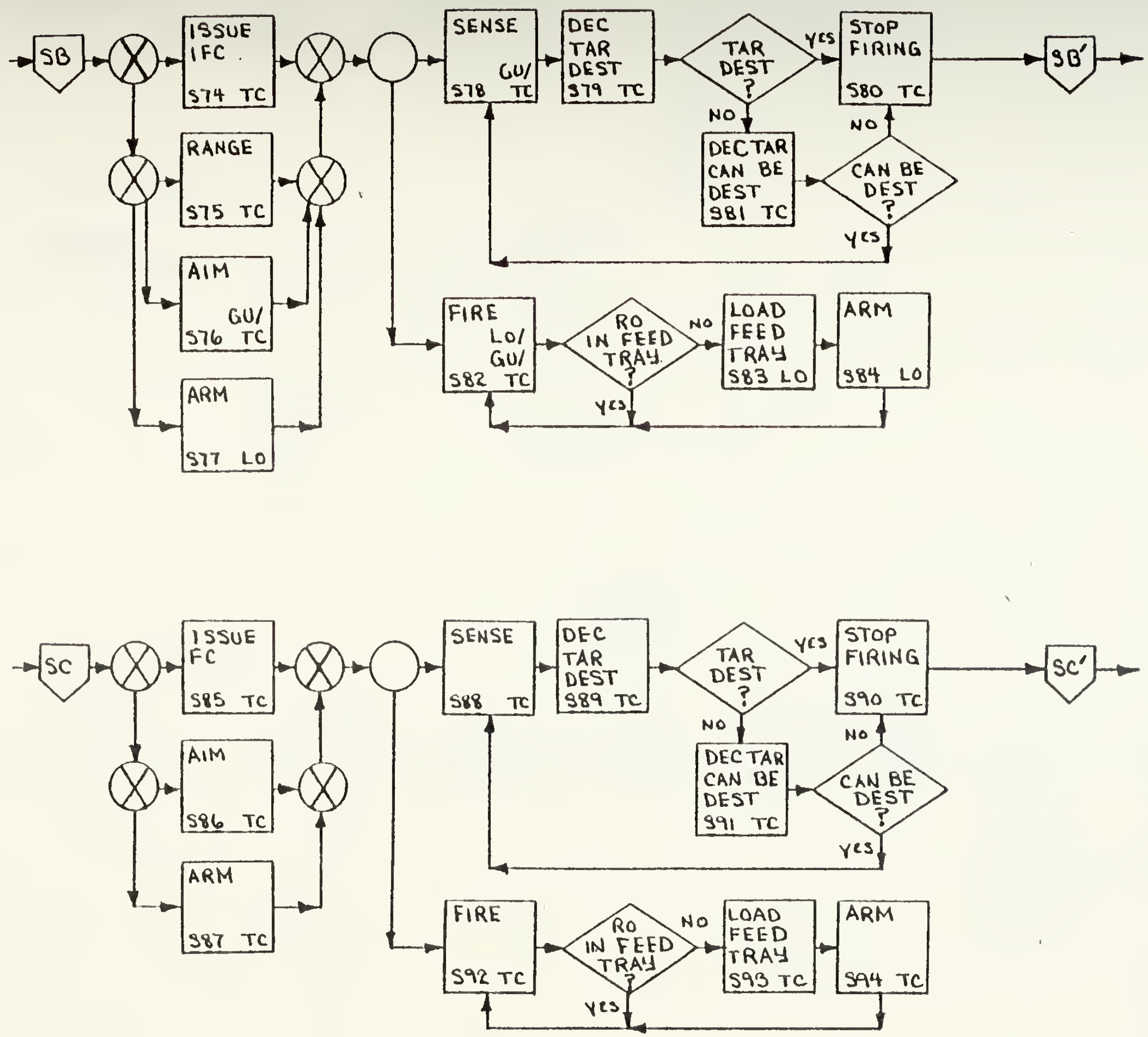
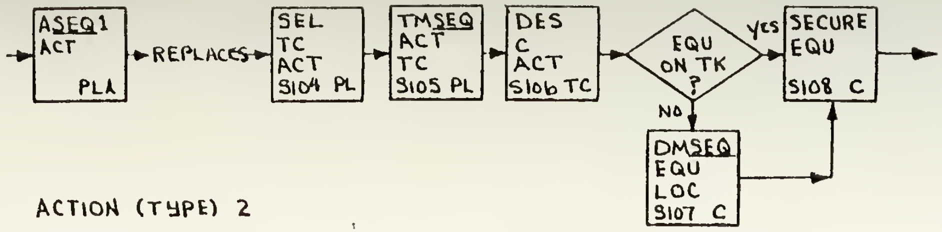
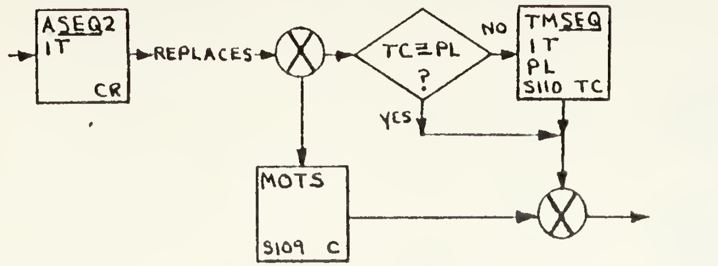


Fig D-6

ACTION (TYPE) 1



ACTION (TYPE) 2



CALL (FOR) FIRE

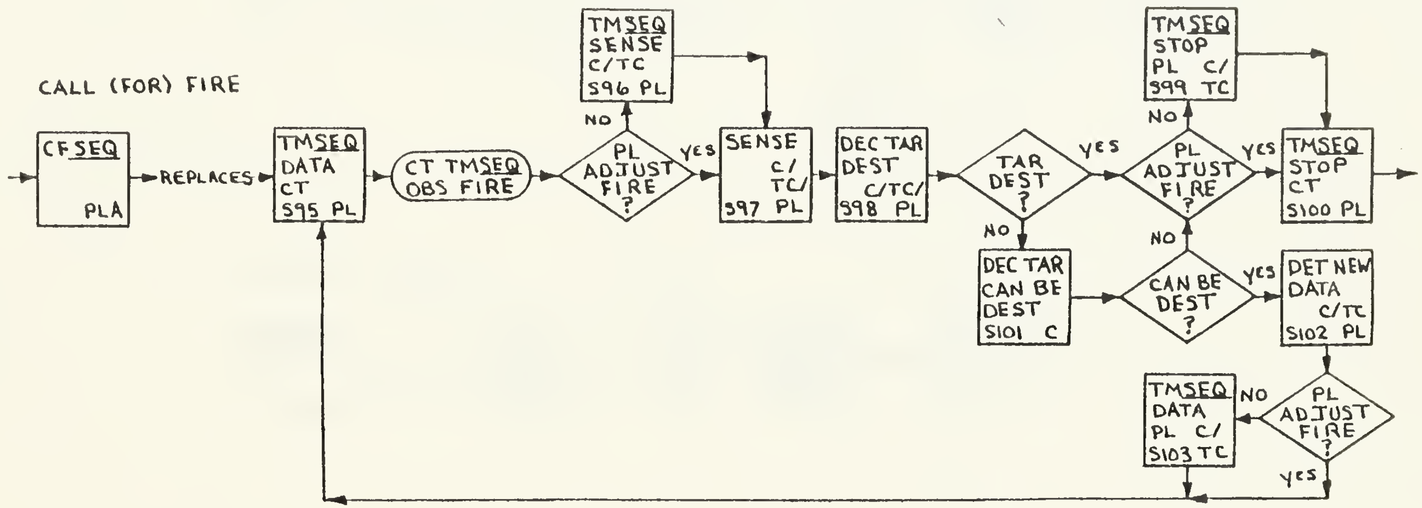
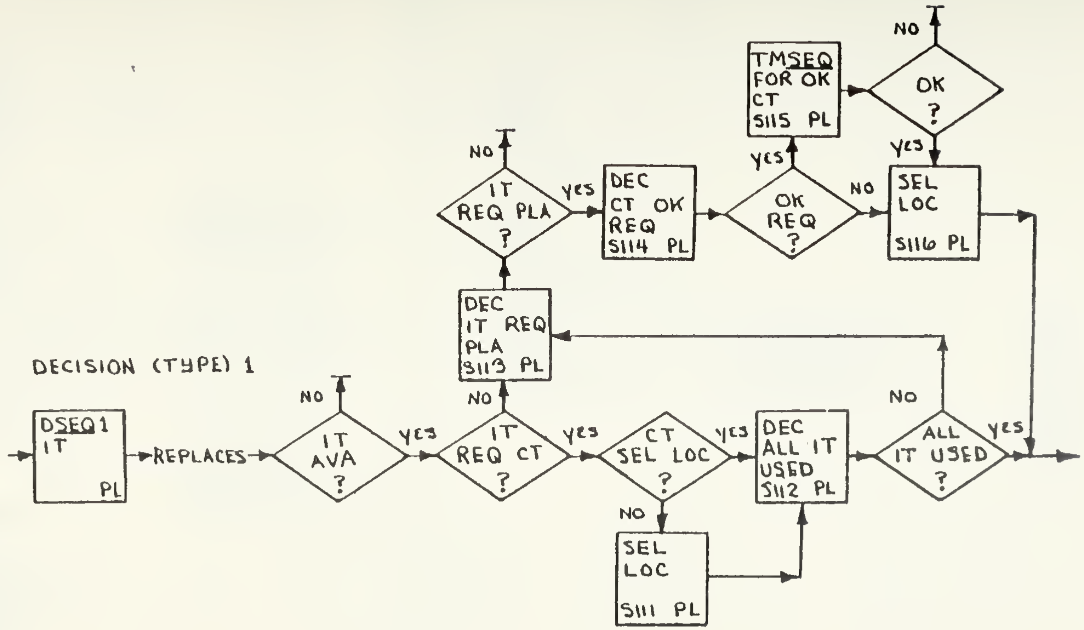


fig D-7

DECISION (TYPE) 1



DECISION (TYPE) 2

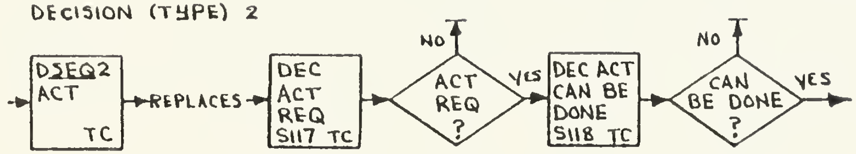


fig D-8

APPENDIX E

SUBPHASES

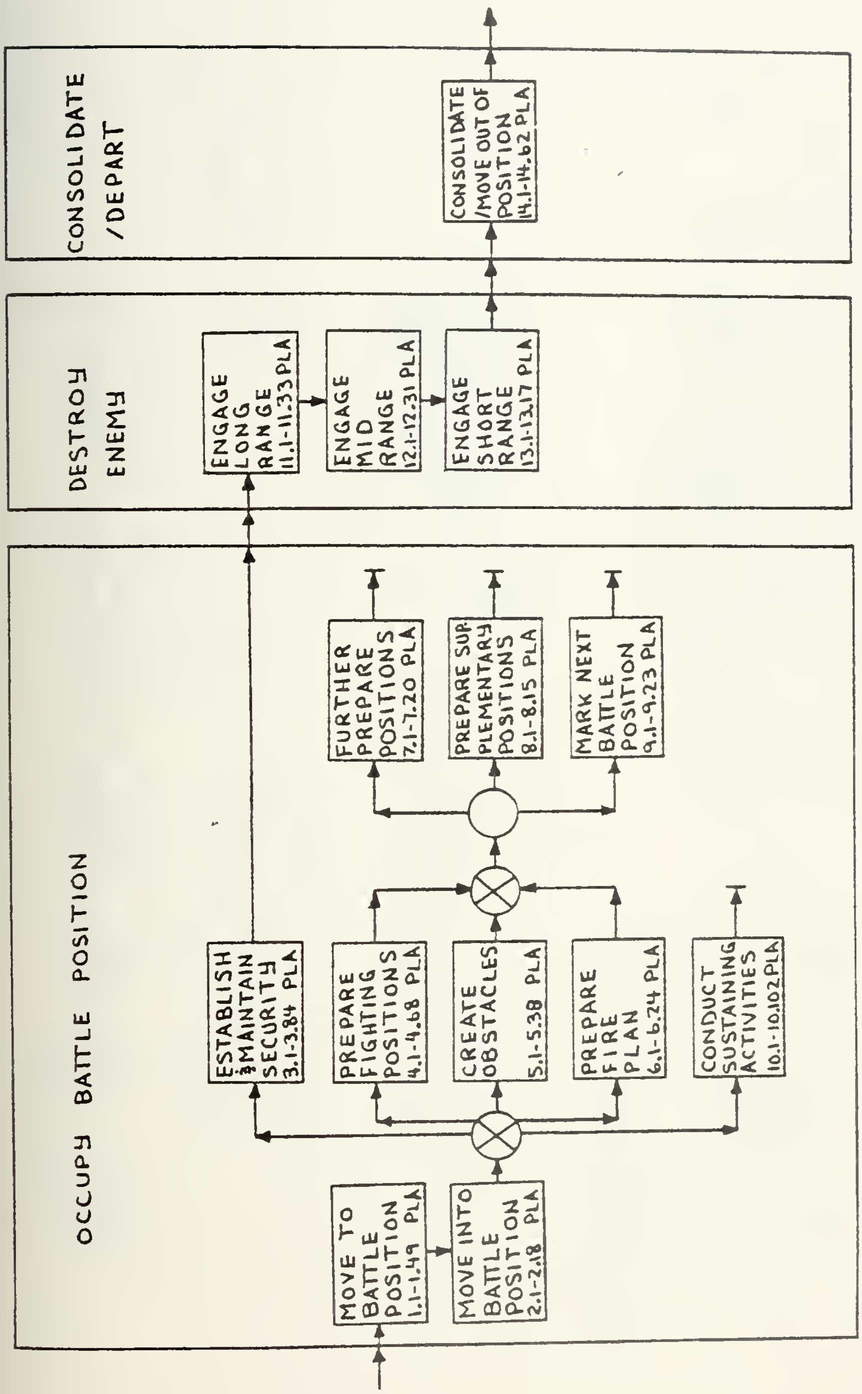


fig E-1

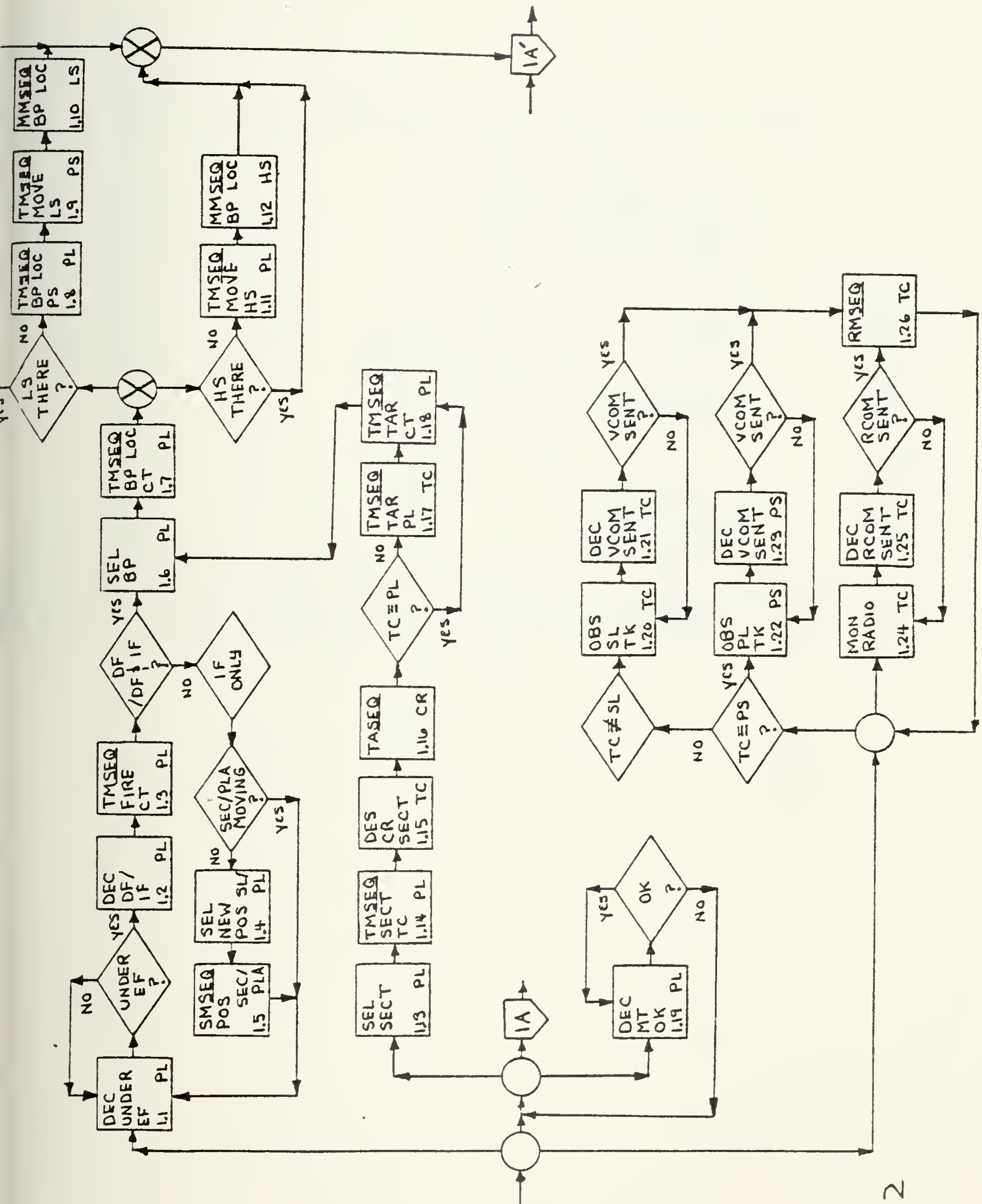
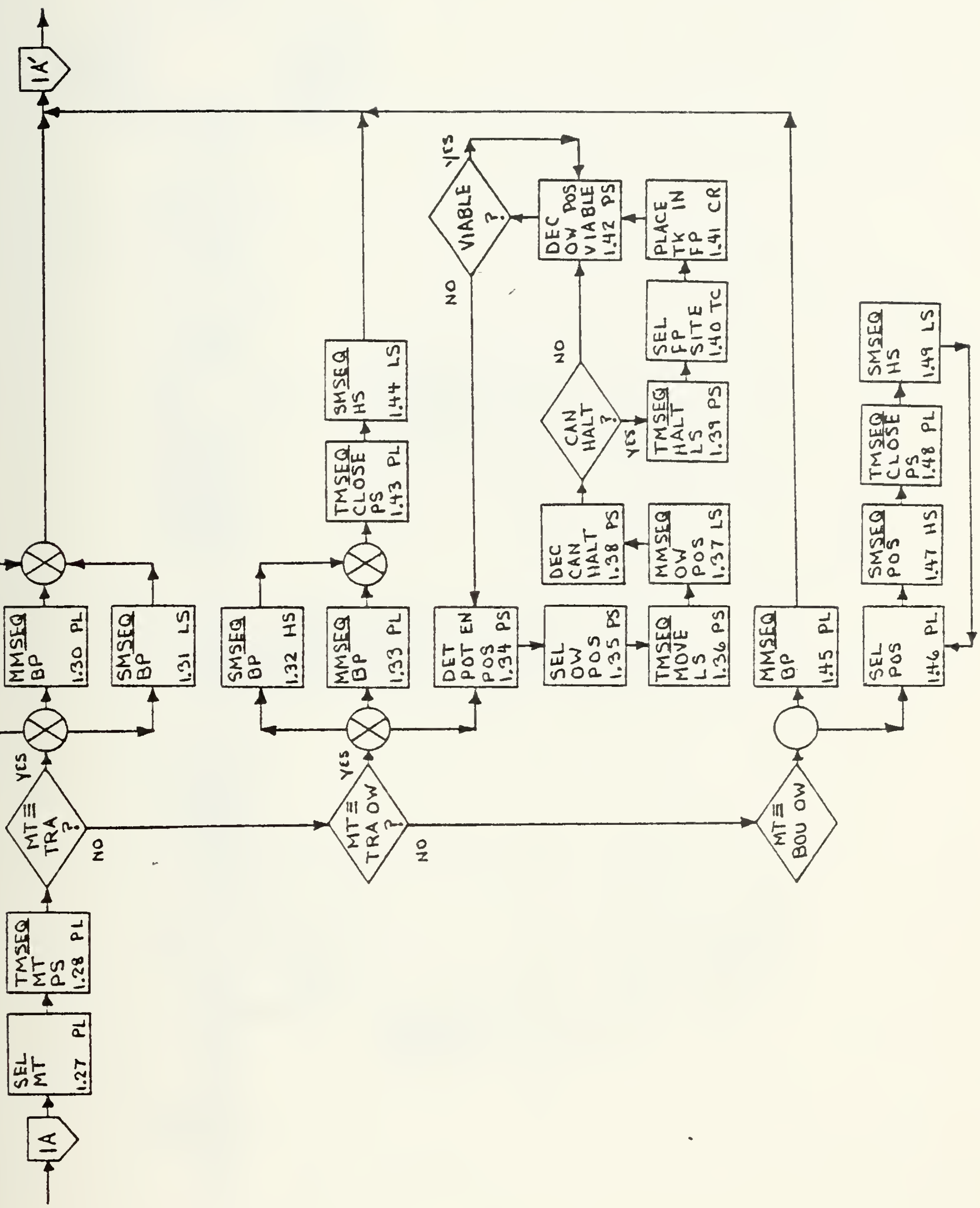

DEC UNDER EF 1.1 PL
UNDER EF ?
YES
NO
DEC DF/IF 1.2 PL
TMSEQ FIRE CT 1.3 PL
DF/DF & IF ?
IF ONLY
SEC/PLA MOVING ?
SEL NEW POS SL 1.4 PL
SMSEQ POS SEC/PLA 1.5 PL
SEL BP 1.6 PL
TMSEQ BP LOC CT 1.7 PL
LS THERE ?
TMSEQ BP LOC PS 1.8 PL
TMSEQ MOVE LS 1.9 PS
MMSEQ BP LOC 1.10 LS
HS THERE ?
TMSEQ MOVE HS 1.11 PL
MMSEQ BP LOC 1.12 HS
1A'
1A
SEL SECT 1.13 PL
TMSEQ SECT TC 1.14 PL
DES CR SECT 1.15 TC
TASEQ 1.16 CR
TC ≡ PL ?
TMSEQ TAR PL 1.17 TC
TMSEQ TAR CT 1.18 PL
DEC MT OK 1.19 PL
OK ?
TC ≢ SL
OBS SL TK 1.20 TC
DEC VCOM SENT 1.21 TC
VCOM SENT ?
TC ≡ PS ?
OBS PL TK 1.22 PS
DEC VCOM SENT 1.23 PS
MON RADIO 1.24 TC
DEC RCOM SENT 1.25 TC
RCOM SENT ?
RMSEQ 1.26 TC

fig E-2



1A
SEL MT 1.27 PL
TMSEQ MT PS 1.28 PL
MT≡ TRA ?
YES
NO
SMSEQ BP 1.29 HS
MMSEQ BP 1.30 PL
SMSEQ BP 1.31 LS
1A'
MT≡ TRA OW ?
YES
NO
SMSEQ BP 1.32 HS
MMSEQ BP 1.33 PL
TMSEQ CLOSE PS 1.43 PL
SMSEQ HS 1.44 LS
DET POT EN POS 1.34 PS
SEL OW POS 1.35 PS
TMSEQ MOVE LS 1.36 PS
MMSEQ OW POS 1.37 LS
DEC CAN HALT 1.38 PS
CAN HALT ?
YES
NO
TMSEQ HALT LS 1.39 PS
SEL FP SITE 1.40 TC
PLACE TK IN FP 1.41 CR
DEC OW POS VIABLE 1.42 PS
VIABLE ?
YES
NO
MT≡ BOU OW
MMSEQ BP 1.45 PL
SEL POS 1.46 PL
SMSEQ POS 1.47 HS
TMSEQ CLOSE PS 1.48 PL
SMSEQ HS 1.49 LS

fig E-3

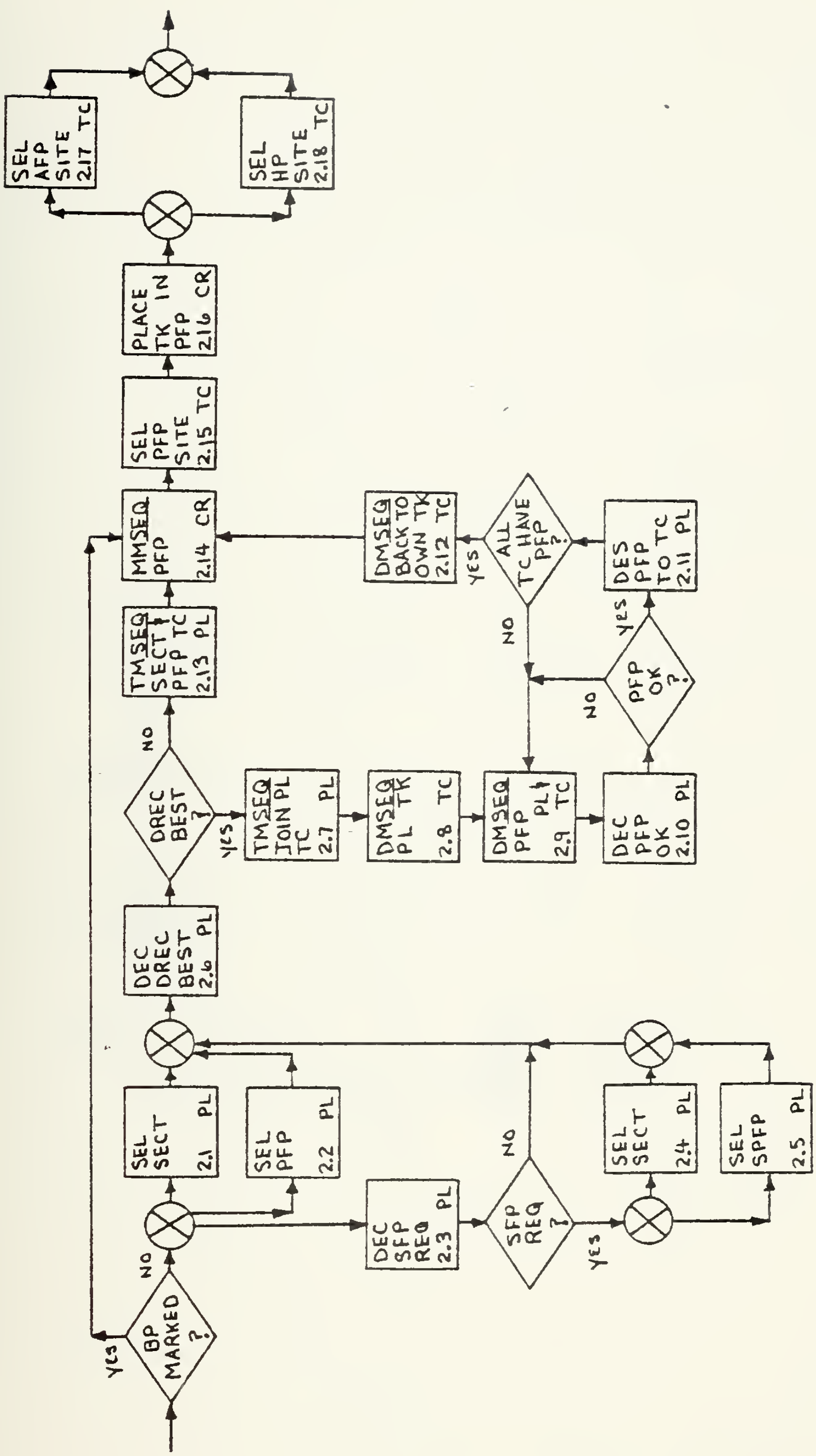

BP MARKED ?
YES
NO
SEL SECT 2.1 PL
SEL PFP 2.2 PL
DEC SFP REQ 2.3 PL
SFP REQ ?
YES
NO
SEL SECT 2.4 PL
SEL SPFP 2.5 PL
DEC DREC BEST 2.6 PL
DREC BEST ?
YES
NO
TMSEQ JOIN PL TC 2.7 PL
DMSEQ PL TK 2.8 TC
DMSEQ PFP PL↑ 2.9 TC
DEC PFP OK 2.10 PL
PFP OK ?
NO
YES
DES PFP TO TC 2.11 PL
ALL TC HAVE PFP ?
NO
YES
DMSEQ BACK TO OWN TK 2.12 TC
TMSEQ SECT↑ PFP TC 2.13 PL
MMSEQ PFP 2.14 CR
SEL PFP SITE 2.15 TC
PLACE TK IN PFP 2.16 CR
SEL AFP SITE 2.17 TC
SEL HP SITE 2.18 TC

fig E-4

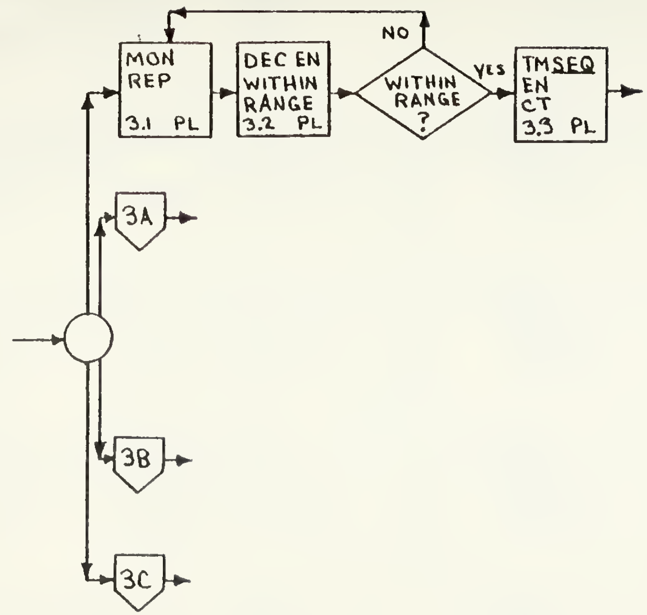

MON
REP
3.1 PL
DEC EN
WITHIN
RANGE
3.2 PL
NO
WITHIN
RANGE
?
YES
TMSEQ
EN
CT
3.3 PL
3A
3B
3C

Fig E-5

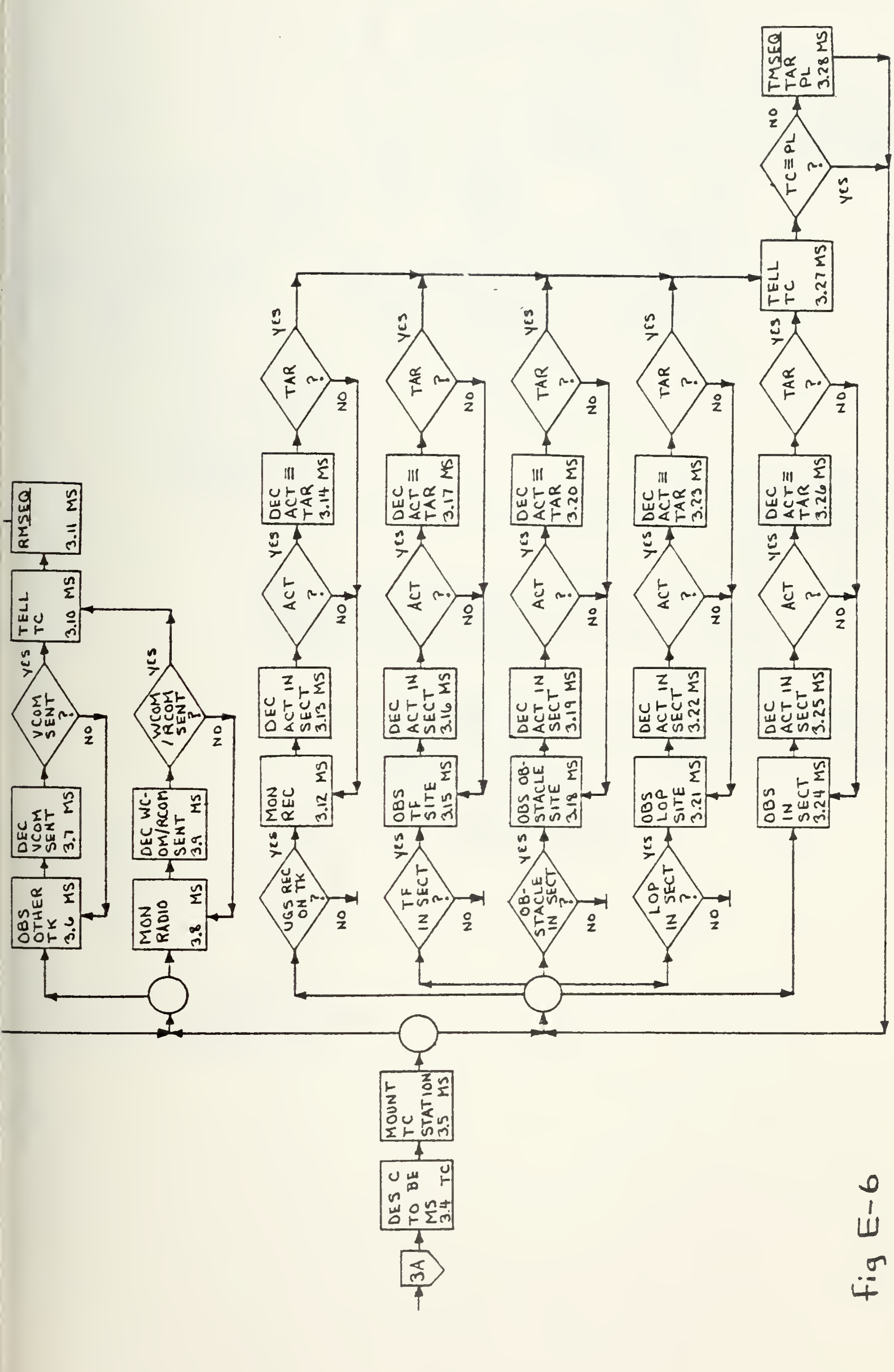

3A
DES C TO BE MS 3.4 TC
MOUNT TC STATION 3.5 MS
OBS OTHER TK 3.6 MS
DEC VCOM SENT 3.7 MS
VCOM SENT ?
YES
NO
TELL TC 3.10 MS
RMSEQ 3.11 MS
MON RADIO 3.8 MS
DEC WCOM/RCOM SENT 3.9 MS
WCOM /RCOM SENT ?
UGS REC ON TK ?
MON REC 3.12 MS
DEC ACT IN SECT 3.13 MS
ACT ?
DEC ACT ≡ TAR 3.14 MS
TAR ?
TF IN SECT ?
OBS TF SITE 3.15 MS
DEC ACT IN SECT 3.16 MS
DEC ACT ≡ TAR 3.17 MS
OBSTACLE IN SECT ?
OBS OBSTACLE SITE 3.18 MS
DEC ACT IN SECT 3.19 MS
DEC ACT ≡ TAR 3.20 MS
LOP IN SECT ?
OBS LOP SITE 3.21 MS
DEC ACT IN SECT 3.22 MS
DEC ACT ≡ TAR 3.23 MS
OBS IN SECT 3.24 MS
DEC ACT IN SECT 3.25 MS
DEC ACT ≡ TAR 3.26 MS
TELL TC 3.27 MS
TC ≡ PL ?
TMSEQ TAR PL 3.28 MS

fig E-6

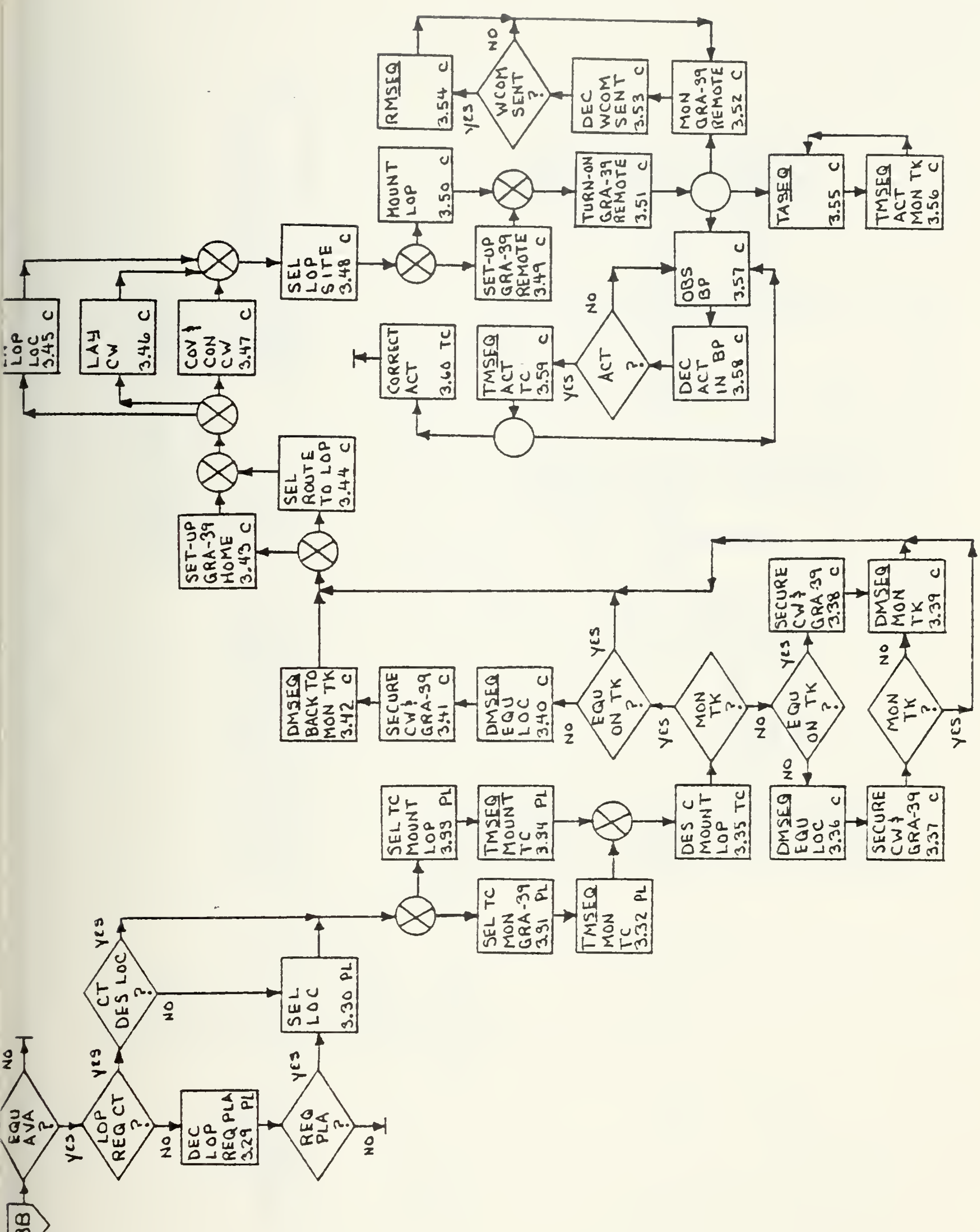
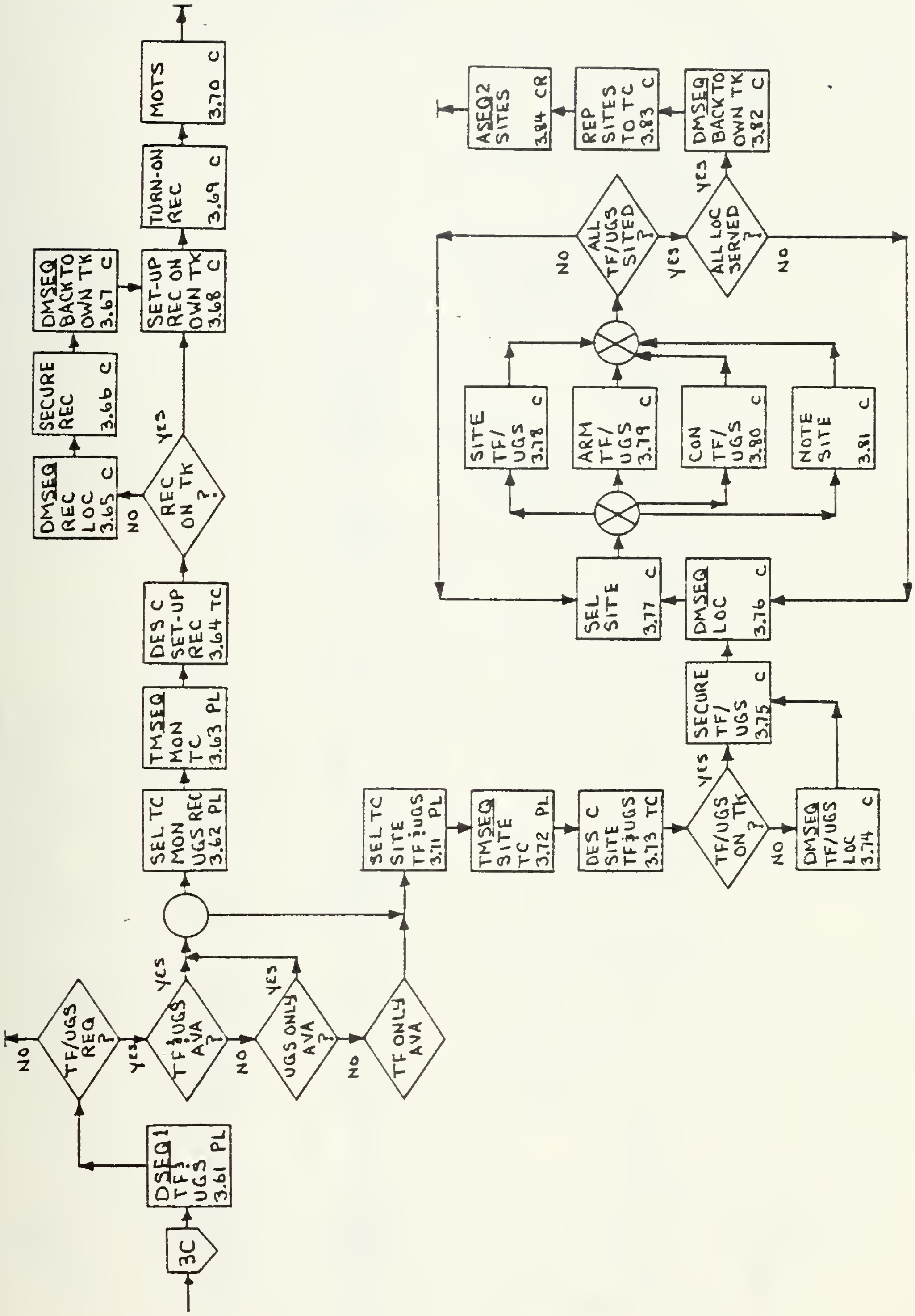

3B
EQU AVA ?
YES
NO
LOP REQ CT ?
DEC LOP REQ PLA 3.29 PL
REQ PLA ?
CT DES LOC ?
SEL LOC 3.30 PL
SEL TC MON GRA-39 3.31 PL
TMSEQ MON TC 3.32 PL
SEL TC MOUNT LOP 3.33 PL
TMSEQ MOUNT TC 3.34 PL
DES C MOUNT LOP 3.35 TC
MON TK ?
EQU ON TK ?
DMSEQ EQU LOC 3.36 C
SECURE CW & GRA-39 3.37 C
SECURE CW & GRA-39 3.38 C
DMSEQ MON TK 3.39 C
DMSEQ EQU LOC 3.40 C
SECURE CW & GRA-39 3.41 C
DMSEQ BACK TO MON TK 3.42 C
SET-UP GRA-39 HOME 3.43 C
SEL ROUTE TO LOP 3.44 C
LOP LOC 3.45 C
LAY CW 3.46 C
COV & CON CW 3.47 C
SEL LOP SITE 3.48 C
SET-UP GRA-39 REMOTE 3.49 C
MOUNT LOP 3.50 C
TURN-ON GRA-39 REMOTE 3.51 C
MON GRA-39 REMOTE 3.52 C
DEC WCOM SENT 3.53 C
WCOM SENT ?
RMSEQ 3.54 C
TASEQ 3.55 C
TMSEQ ACT MON TK 3.56 C
OBS BP 3.57 C
DEC ACT IN BP 3.58 C
ACT ?
TMSEQ ACT TC 3.59 C
CORRECT ACT 3.60 TC

fig E-7



3C
DSEQ1 TF; UGS 3.61 PL
TF/UGS REQ ?
NO
YES
TF; UGS AVA ?
UGS ONLY AVA ?
TF ONLY AVA
SEL TC MON UGS REC 3.62 PL
TMSEQ MON TC 3.63 PL
DES C SET-UP REC 3.64 TC
REC ON TK ?
DMSEQ REC LOC 3.65 C
SECURE REC 3.66 C
DMSEQ BACK TO OWN TK 3.67 C
SET-UP REC ON OWN TK 3.68 C
TURN-ON REC 3.69 C
MOTS 3.70 C
SEL TC SITE TF; UGS 3.71 PL
TMSEQ SITE TC 3.72 PL
DES C SITE TF; UGS 3.73 TC
TF/UGS ON TK ?
DMSEQ TF/UGS LOC 3.74 C
SECURE TF/ UGS 3.75 C
DMSEQ LOC 3.76 C
SEL SITE 3.77 C
SITE TF/ UGS 3.78 C
ARM TF/ UGS 3.79 C
CON TF/ UGS 3.80 C
NOTE SITE 3.81 C
ALL TF/UGS SITED ?
ALL LOC SERVED ?
DMSEQ BACK TO OWN TK 3.82 C
REP SITES TO TC 3.83 C
ASEQ2 SITES 3.84 CR

fig E-8

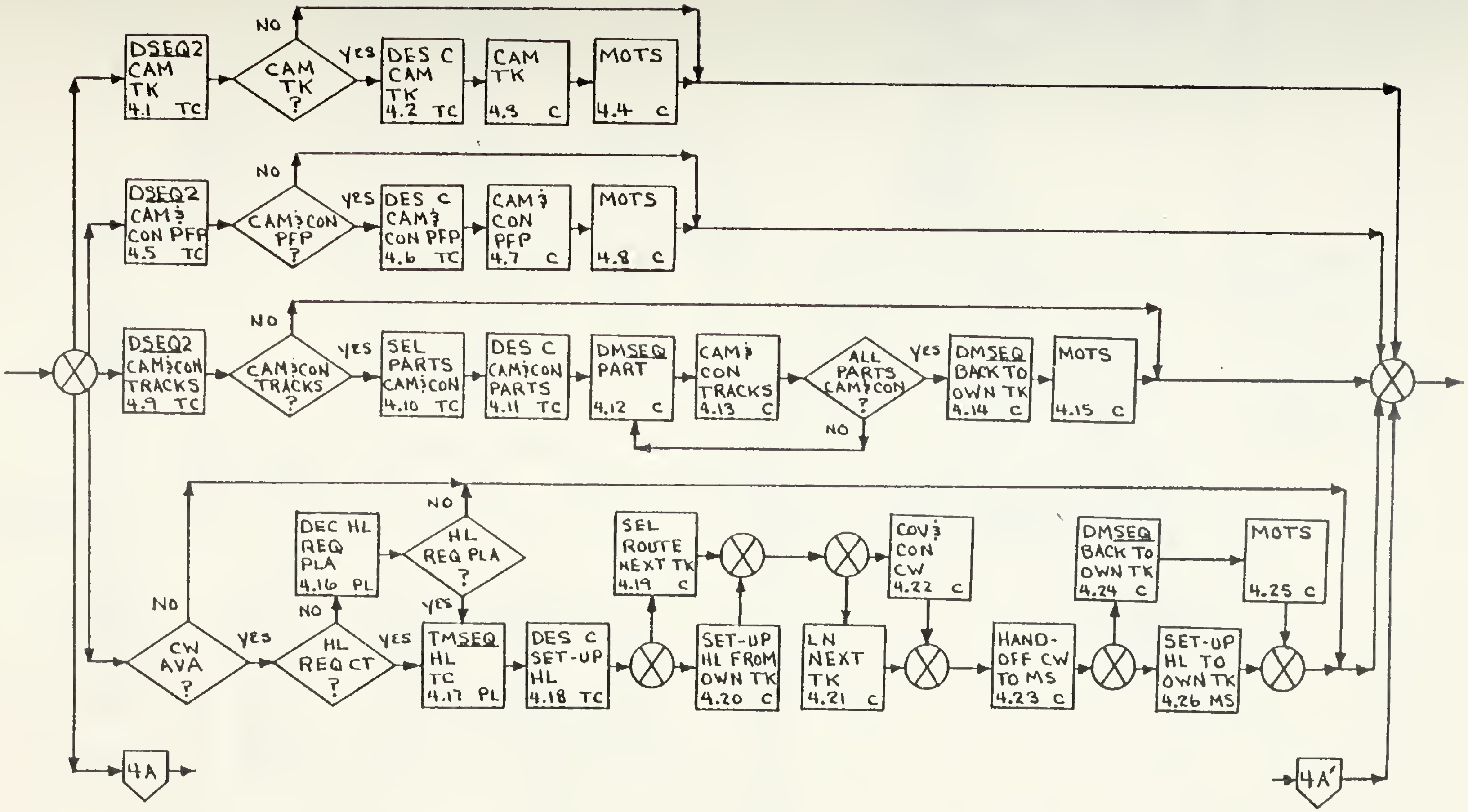

DSEQ2 CAM TK 4.1 TC
CAM TK ?
NO
YES
DES C CAM TK 4.2 TC
CAM TK 4.3 C
MOTS 4.4 C
DSEQ2 CAM & CON PFP 4.5 TC
CAM & CON PFP ?
DES C CAM & CON PFP 4.6 TC
CAM & CON PFP 4.7 C
MOTS 4.8 C
DSEQ2 CAM & CON TRACKS 4.9 TC
CAM & CON TRACKS ?
SEL PARTS CAM & CON 4.10 TC
DES C CAM & CON PARTS 4.11 TC
DMSEQ PART 4.12 C
CAM & CON TRACKS 4.13 C
ALL PARTS CAM & CON ?
DMSEQ BACK TO OWN TK 4.14 C
MOTS 4.15 C
CW AVA ?
HL REQ CT ?
DEC HL REQ PLA 4.16 PL
HL REQ PLA ?
TMSEQ HL TC 4.17 PL
DES C SET-UP HL 4.18 TC
SEL ROUTE NEXT TK 4.19 C
SET-UP HL FROM OWN TK 4.20 C
LN NEXT TK 4.21 C
COV & CON CW 4.22 C
HAND-OFF CW TO MS 4.23 C
DMSEQ BACK TO OWN TK 4.24 C
MOTS 4.25 C
SET-UP HL TO OWN TK 4.26 MS
4A
4A'

fig E-9

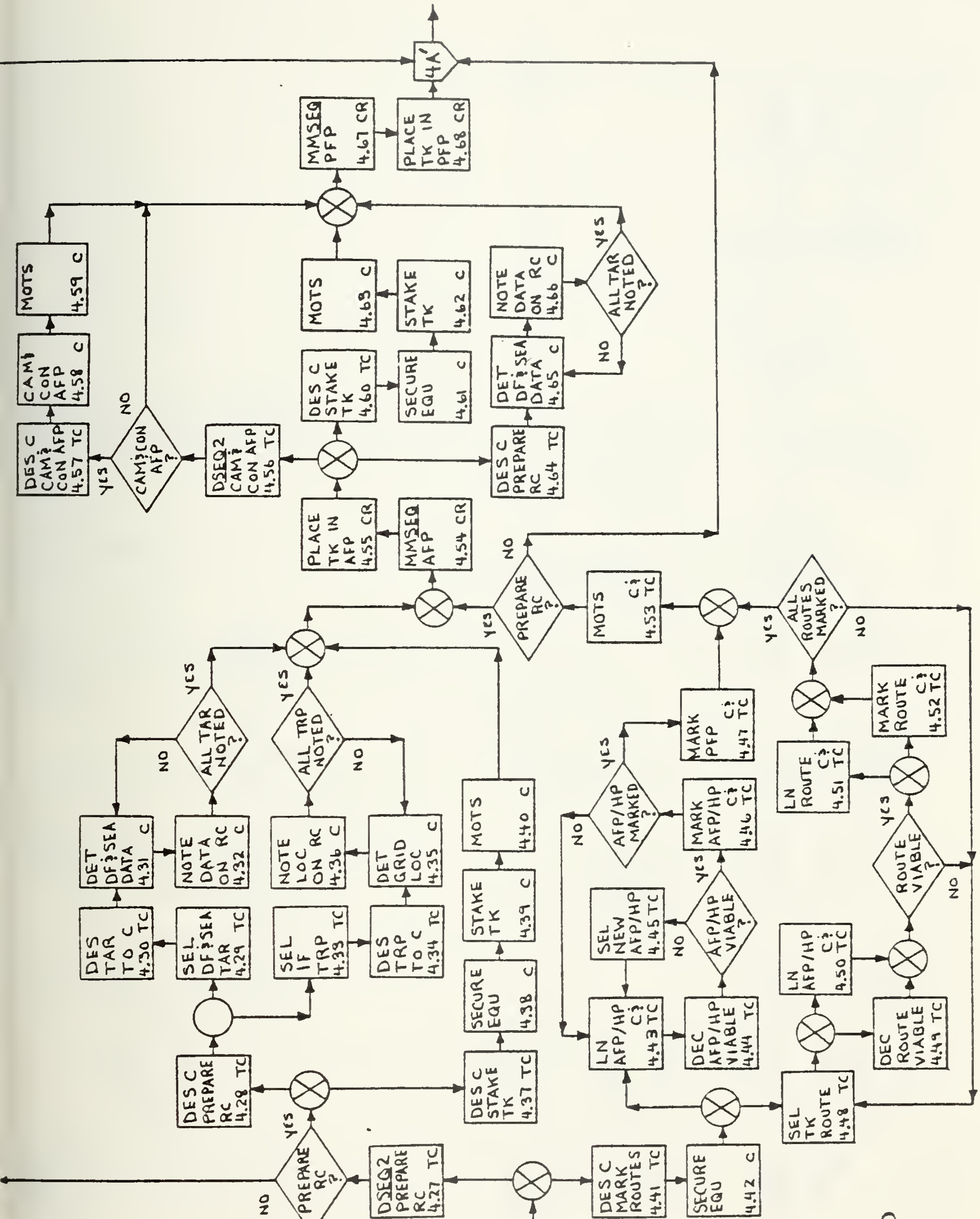

DES C CAM& CON AFP 4.57 TC
CAM& CON AFP 4.58 C
MOTS 4.59 C
CAM&CON AFP ?
YES
NO
DSEQ2 CAM& CON AFP 4.56 TC
PLACE TK IN AFP 4.55 CR
MMSEQ AFP 4.54 CR
DES C STAKE TK 4.60 TC
SECURE EQU 4.61 C
STAKE TK 4.62 C
MOTS 4.63 C
MMSEQ PFP 4.67 CR
PLACE TK IN PFP 4.68 CR
4A'
DES C PREPARE RC 4.64 TC
DET DF&SEA DATA 4.65 C
NOTE DATA ON RC 4.66 C
ALL TAR NOTED ?
PREPARE RC ?
MOTS C& 4.53 TC
ALL ROUTES MARKED ?
DSEQ2 PREPARE RC 4.27 TC
PREPARE RC ?
4A
DES C MARK ROUTES 4.41 TC
SECURE EQU 4.42 C
DES C PREPARE RC 4.28 TC
DES C STAKE TK 4.37 TC
DES TAR TO C 4.30 TC
DET DF&SEA DATA 4.31 C
SEL DF&SEA TAR 4.29 TC
NOTE DATA ON RC 4.32 C
ALL TAR NOTED ?
SEL IF TRP 4.33 TC
NOTE LOC ON RC 4.36 C
DES TRP TO C 4.34 TC
DET GRID LOC 4.35 C
ALL TRP NOTED ?
SECURE EQU 4.38 C
STAKE TK 4.39 C
MOTS 4.40 C
LN AFP/HP C& 4.43 TC
SEL NEW AFP/HP 4.45 TC
DEC AFP/HP VIABLE 4.44 TC
AFP/HP VIABLE ?
MARK AFP/HP C& 4.46 TC
AFP/HP MARKED ?
MARK PFP C& 4.47 TC
SEL TK ROUTE 4.48 TC
LN AFP/HP C& 4.50 TC
DEC ROUTE VIABLE 4.49 TC
ROUTE VIABLE ?
LN ROUTE C& 4.51 TC
MARK ROUTE C& 4.52 TC

fig E-10

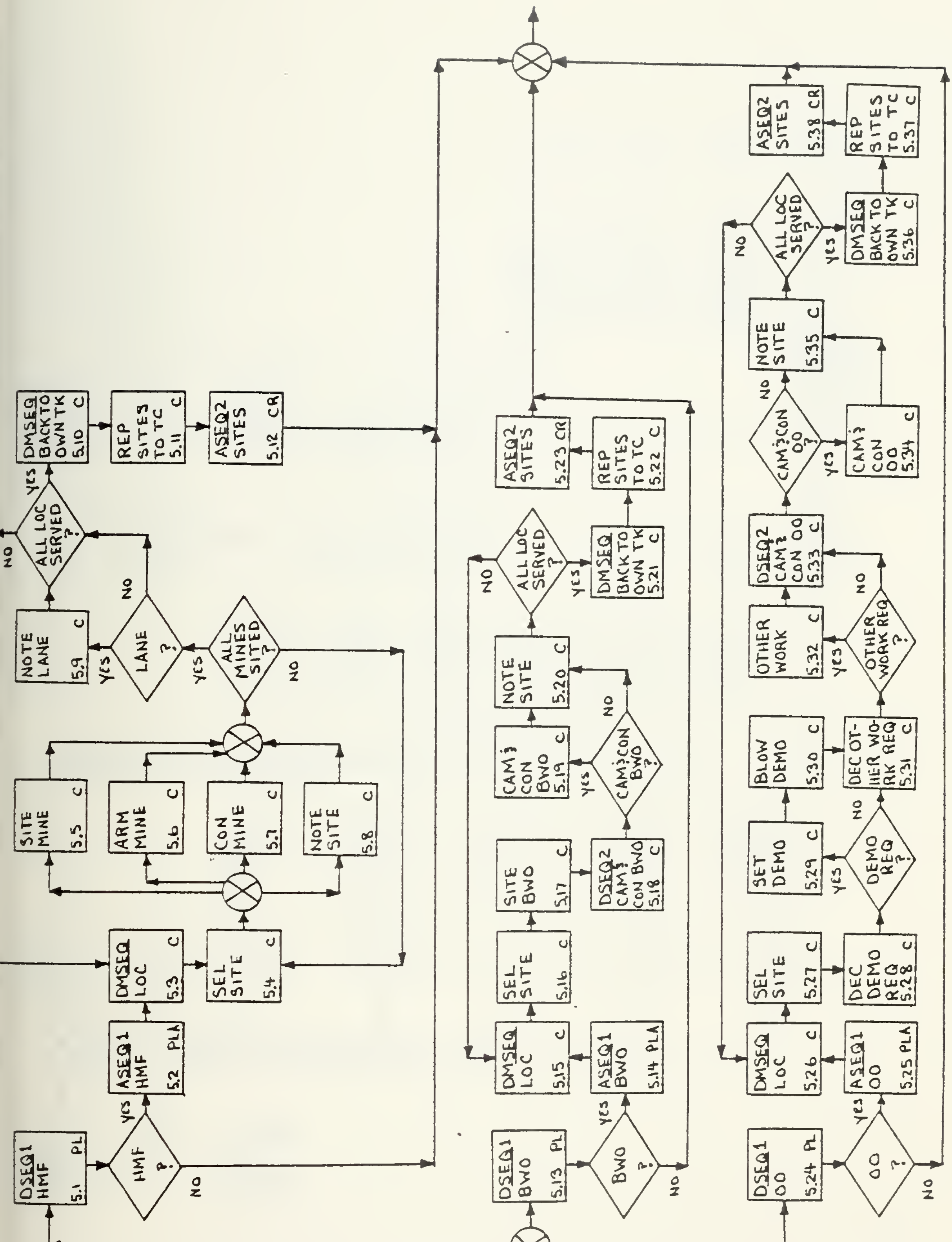

DSEQ1 HMF 5.1 PL
HMF ?
YES
NO
ASEQ1 HMF 5.2 PLA
DMSEQ LOC 5.3 C
SEL SITE 5.4 C
SITE MINE 5.5 C
ARM MINE 5.6 C
CON MINE 5.7 C
NOTE SITE 5.8 C
ALL MINES SITED ?
LANE ?
NOTE LANE 5.9 C
ALL LOC SERVED ?
DMSEQ BACK TO OWN TK 5.10 C
REP SITES TO TC 5.11 C
ASEQ2 SITES 5.12 CR
DSEQ1 BWO 5.13 PL
BWO ?
ASEQ1 BWO 5.14 PLA
DMSEQ LOC 5.15 C
SEL SITE 5.16 C
SITE BWO 5.17 C
DSEQ2 CAM? CON BWO 5.18 C
CAM?CON BWO ?
CAM? CON BWO 5.19 C
NOTE SITE 5.20 C
DMSEQ BACK TO OWN TK 5.21 C
REP SITES TO TC 5.22 C
ASEQ2 SITES 5.23 CR
DSEQ1 OO 5.24 PL
OO ?
ASEQ1 OO 5.25 PLA
DMSEQ LOC 5.26 C
SEL SITE 5.27 C
DEC DEMO REQ 5.28 C
DEMO REQ ?
SET DEMO 5.29 C
BLOW DEMO 5.30 C
DEC OTHER WORK REQ 5.31 C
OTHER WORK REQ ?
OTHER WORK 5.32 C
DSEQ2 CAM? CON OO 5.33 C
CAM?CON OO ?
CAM? CON OO 5.34 C
NOTE SITE 5.35 C
DMSEQ BACK TO OWN TK 5.36 C
REP SITES TO TC 5.37 C
ASEQ2 SITES 5.38 CR

fig E-11

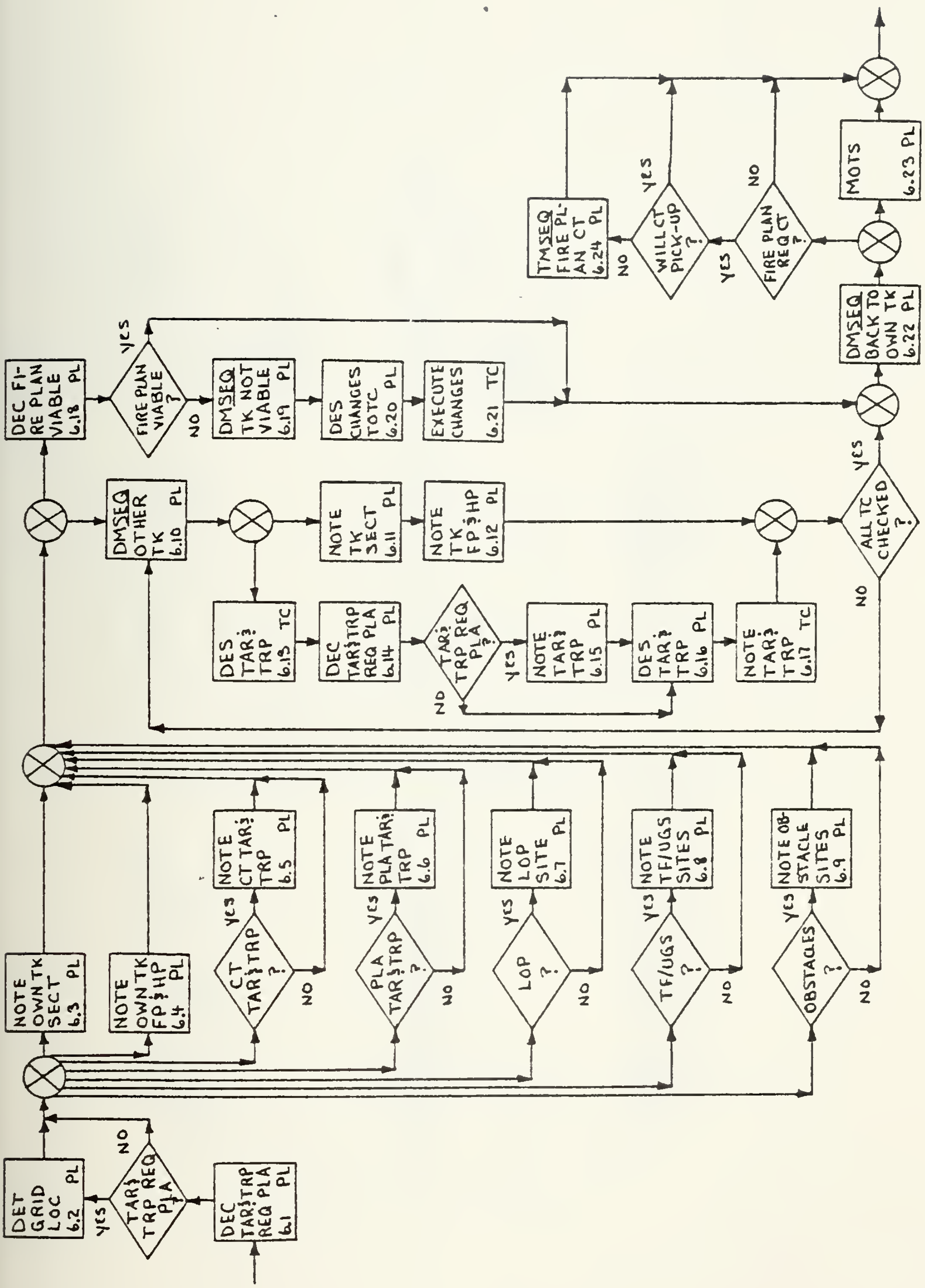

DEC TAR&TRP REQ PLA 6.1 PL
TAR& TRP REQ PLA ?
YES
NO
DET GRID LOC 6.2 PL
NOTE OWN TK SECT 6.3 PL
NOTE OWN TK FP&HP 6.4 PL
CT TAR&TRP ?
NOTE CT TAR& TRP 6.5 PL
PLA TAR&TRP ?
NOTE PLA TAR& TRP 6.6 PL
LOP ?
NOTE LOP SITE 6.7 PL
TF/UGS ?
NOTE TF/UGS SITES 6.8 PL
OBSTACLES ?
NOTE OBSTACLE SITES 6.9 PL
DMSEQ OTHER TK 6.10 PL
NOTE TK SECT 6.11 PL
NOTE TK FP&HP 6.12 PL
DES TAR& TRP 6.13 TC
DEC TAR&TRP REQ PLA 6.14 PL
TAR& TRP REQ PLA ?
NOTE TAR& TRP 6.15 PL
DES TAR& TRP 6.16 PL
NOTE TAR& TRP 6.17 TC
ALL TC CHECKED ?
DEC FIRE PLAN VIABLE 6.18 PL
FIRE PLAN VIABLE ?
DMSEQ TK NOT VIABLE 6.19 PL
DES CHANGES TO TC 6.20 PL
EXECUTE CHANGES 6.21 TC
DMSEQ BACK TO OWN TK 6.22 PL
FIRE PLAN REQ CT ?
WILL CT PICK-UP ?
TMSEQ FIRE PLAN CT 6.24 PL
MOTS 6.23 PL

Fig E-12

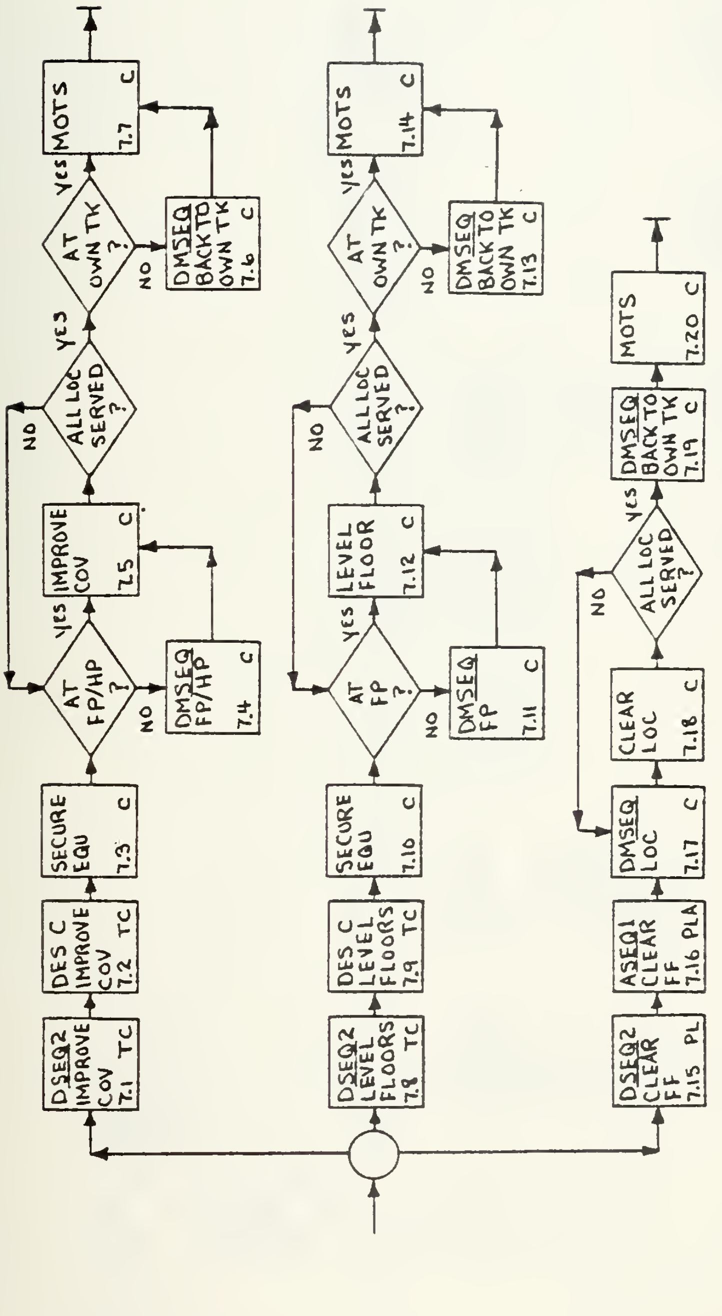

DSEQ2 IMPROVE COV 7.1 TC
DES C IMPROVE COV 7.2 TC
SECURE EQU 7.3 C
AT FP/HP ?
YES
NO
DMSEQ FP/HP 7.4 C
IMPROVE COV 7.5 C
ALL LOC SERVED ?
YES
NO
AT OWN TK ?
YES
NO
DMSEQ BACK TO OWN TK 7.6 C
MOTS 7.7 C
DSEQ2 LEVEL FLOORS 7.8 TC
DES C LEVEL FLOORS 7.9 TC
SECURE EQU 7.10 C
AT FP ?
YES
NO
DMSEQ FP 7.11 C
LEVEL FLOOR 7.12 C
ALL LOC SERVED ?
YES
NO
AT OWN TK ?
YES
NO
DMSEQ BACK TO OWN TK 7.13 C
MOTS 7.14 C
DSEQ2 CLEAR FF 7.15 PL
ASEQ1 CLEAR FF 7.16 PLA
DMSEQ LOC 7.17 C
CLEAR LOC 7.18 C
ALL LOC SERVED ?
YES
NO
DMSEQ BACK TO OWN TK 7.19 C
MOTS 7.20 C

fig E-13

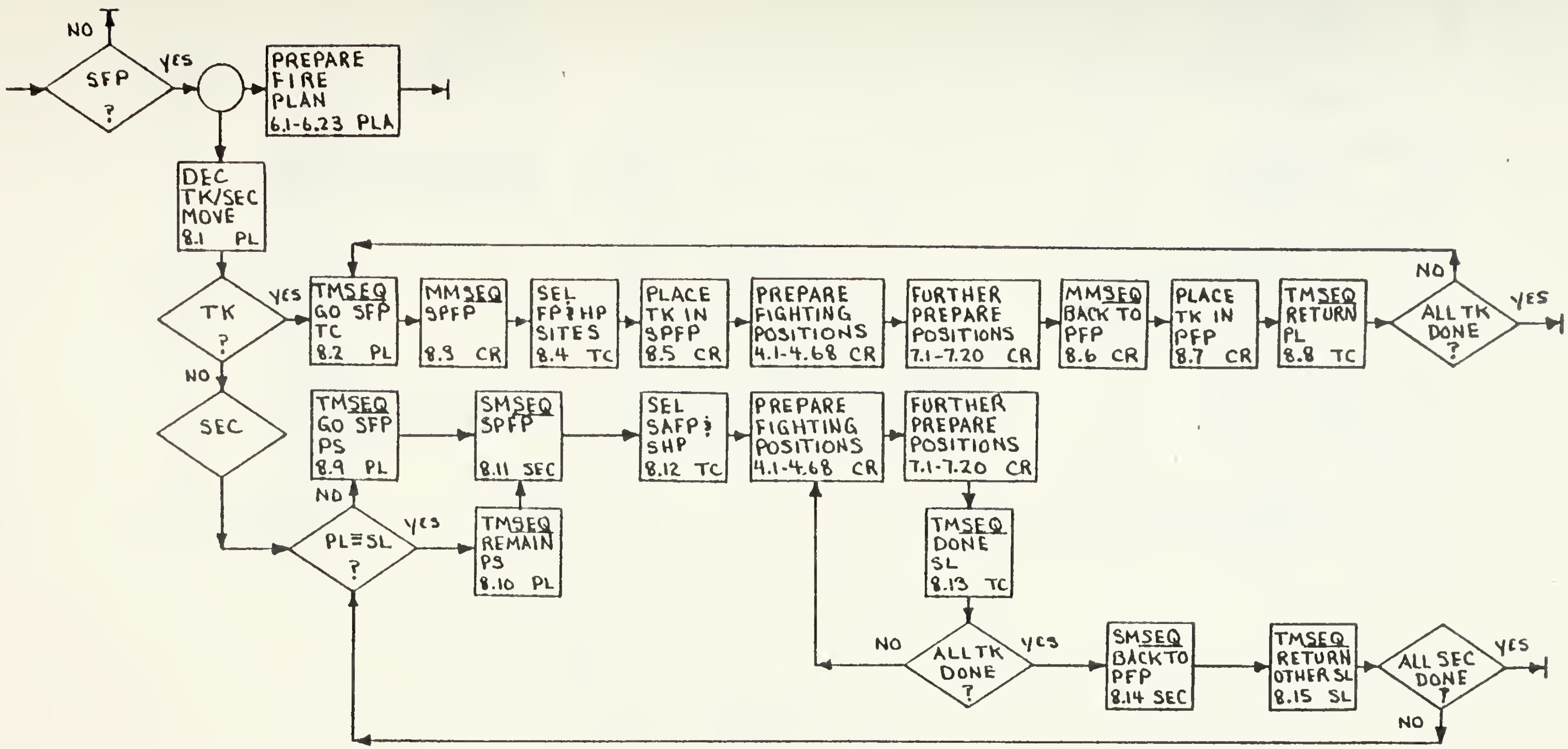
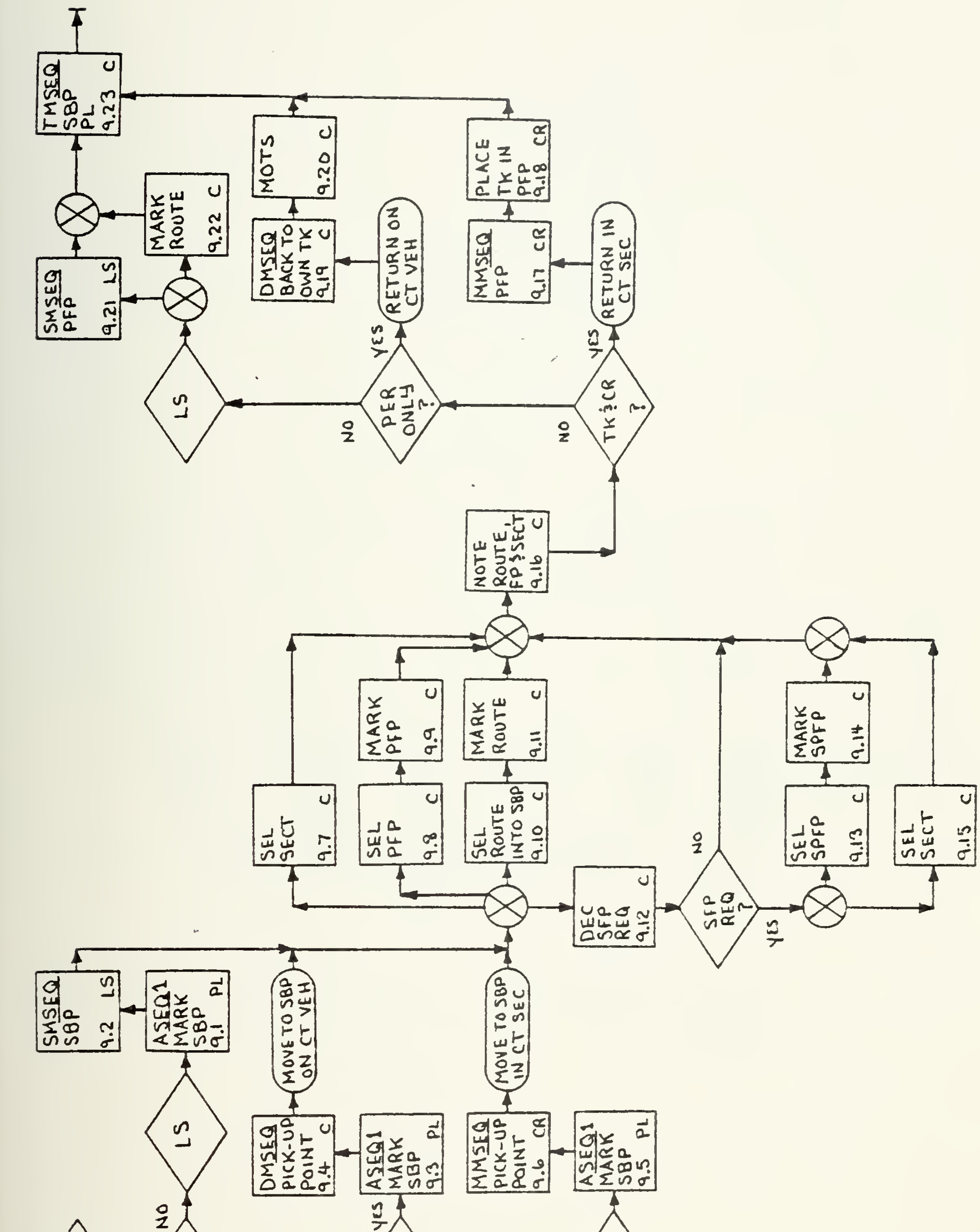

SFP ?
NO
YES
PREPARE FIRE PLAN 6.1-6.23 PLA
DEC TK/SEC MOVE 8.1 PL
TK ?
YES
NO
TMSEQ GO SFP TC 8.2 PL
MMSEQ SPFP 8.3 CR
SEL FP & HP SITES 8.4 TC
PLACE TK IN SPFP 8.5 CR
PREPARE FIGHTING POSITIONS 4.1-4.68 CR
FURTHER PREPARE POSITIONS 7.1-7.20 CR
MMSEQ BACK TO PFP 8.6 CR
PLACE TK IN PFP 8.7 CR
TMSEQ RETURN PL 8.8 TC
ALL TK DONE ?
NO
YES
SEC
PL≡SL ?
NO
YES
TMSEQ GO SFP PS 8.9 PL
TMSEQ REMAIN PS 8.10 PL
SMSEQ SPFP 8.11 SEC
SEL SAFP & SHP 8.12 TC
PREPARE FIGHTING POSITIONS 4.1-4.68 CR
FURTHER PREPARE POSITIONS 7.1-7.20 CR
TMSEQ DONE SL 8.13 TC
ALL TK DONE ?
NO
YES
SMSEQ BACK TO PFP 8.14 SEC
TMSEQ RETURN OTHER SL 8.15 SL
ALL SEC DONE ?
YES
NO

fig E-14



SBP REQ CT ?
NO
YES
CT 1/4 PARTY ?
NO
YES
LS
ASEQ1 MARK SBP 9.1 PL
SMSEQ SBP 9.2 LS
PER ONLY ?
YES
NO
ASEQ1 MARK SBP 9.3 PL
DMSEQ PICK-UP POINT 9.4 C
MOVE TO SBP ON CT VEH
TK & CR
ASEQ1 MARK SBP 9.5 PL
MMSEQ PICK-UP POINT 9.6 CR
MOVE TO SBP IN CT SEC
SEL SECT 9.7 C
SEL PFP 9.8 C
MARK PFP 9.9 C
SEL ROUTE INTO SBP 9.10 C
MARK ROUTE 9.11 C
DEC SFP REQ 9.12 C
SFP REQ ?
YES
NO
SEL SPFP 9.13 C
MARK SPFP 9.14 C
SEL SECT 9.15 C
NOTE ROUTE, FP & SECT 9.16 C
TK & CR ?
NO
YES
RETURN IN CT SEC
MMSEQ PFP 9.17 CR
PLACE TK IN PFP 9.18 CR
PER ONLY ?
NO
YES
RETURN ON CT VEH
DMSEQ BACK TO OWN TK 9.19 C
MOTS 9.20 C
LS
SMSEQ PFP 9.21 LS
MARK ROUTE 9.22 C
TMSEQ SBP PL 9.23 C

Fig E-15

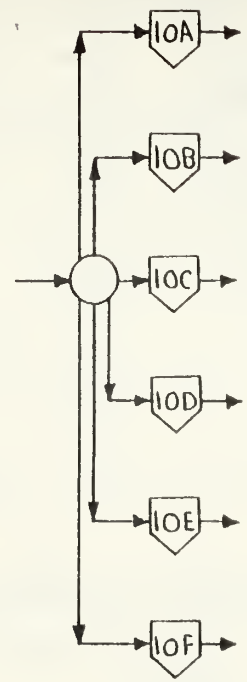


fig E-16

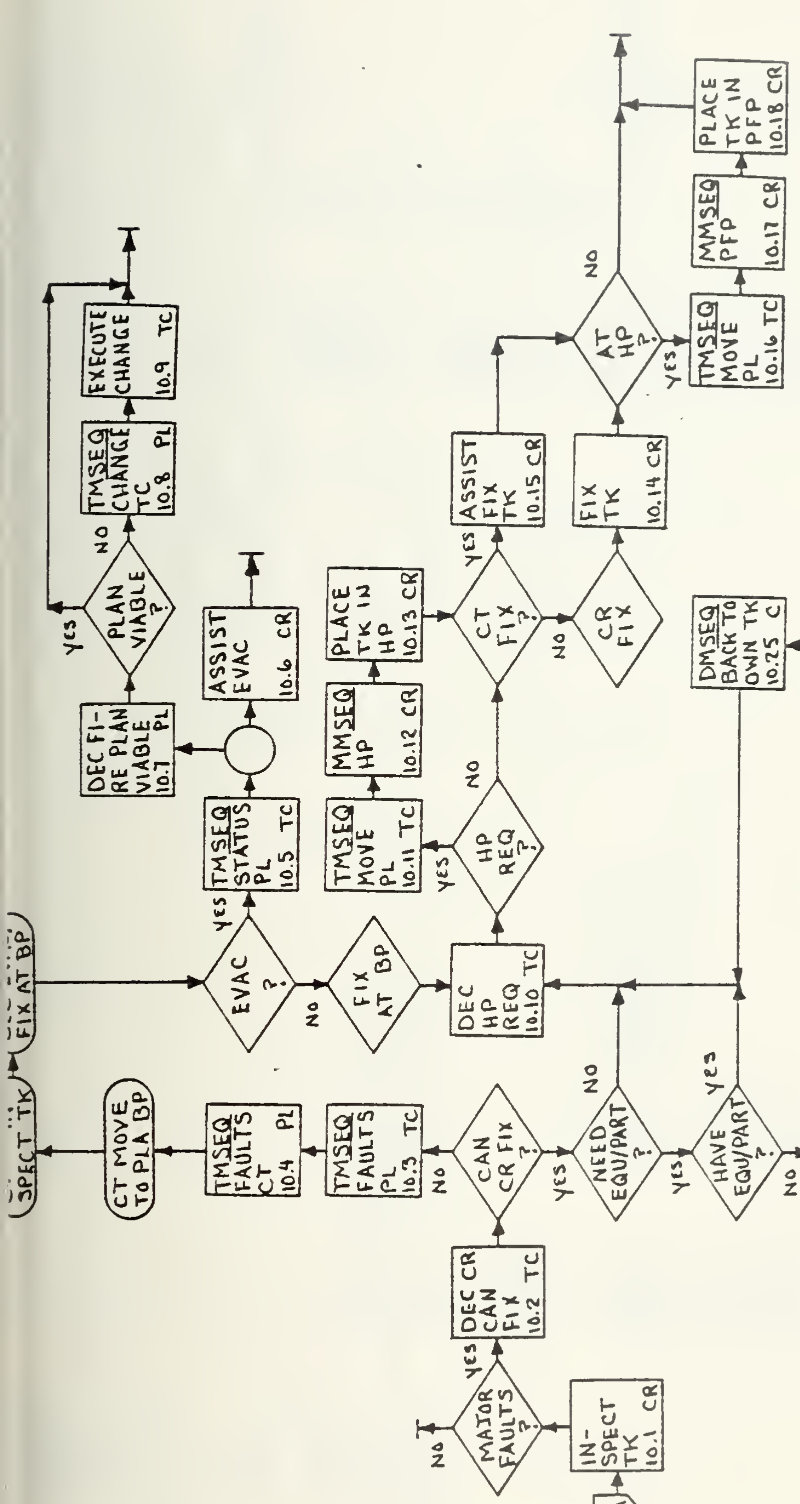
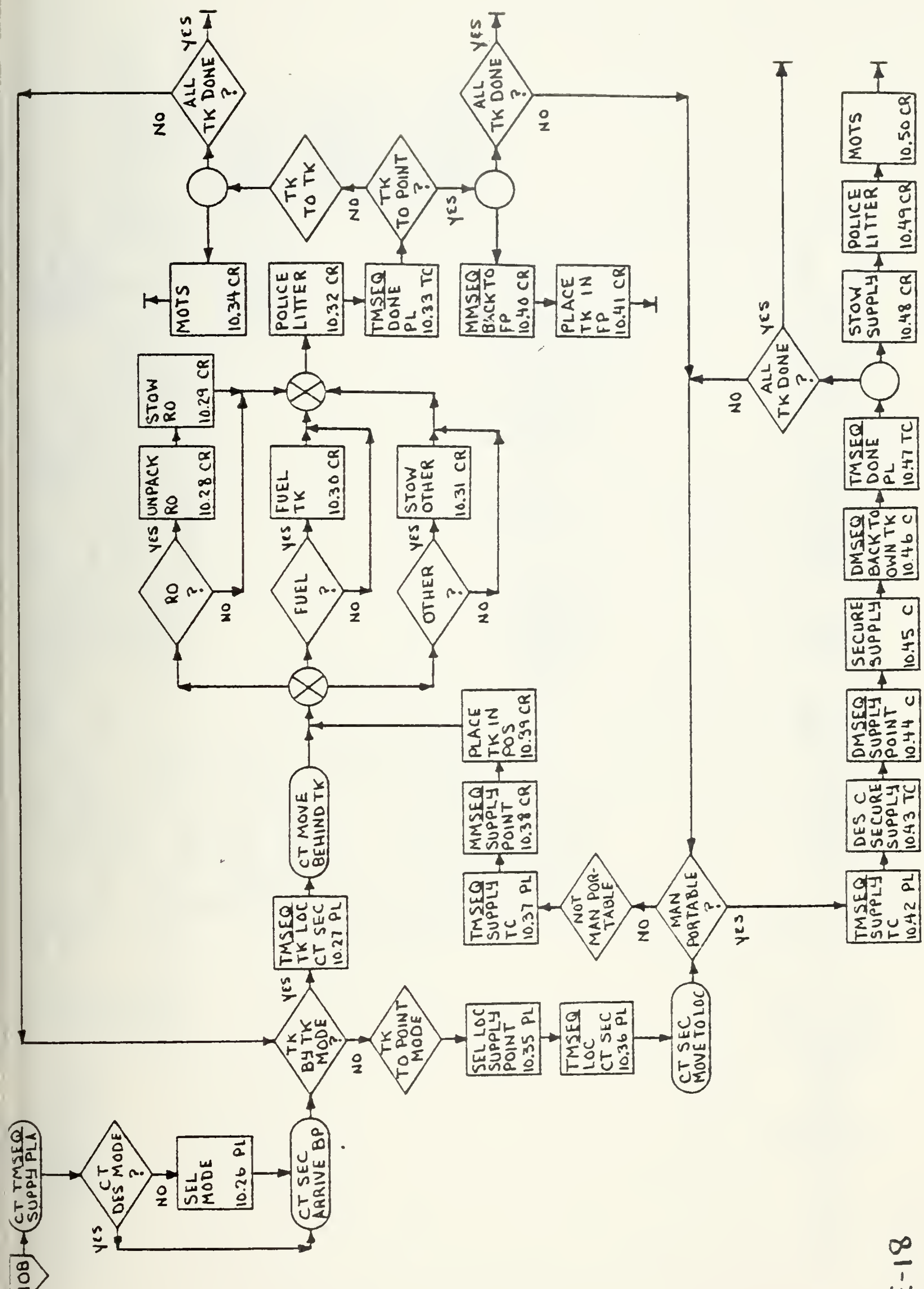

10A
IN-SPECT TK 10.1 CR
MAJOR FAULTS ?
NO
YES
DEC CR CAN FIX 10.2 TC
CAN CR FIX ?
NO
YES
TMSEQ FAULTS PL 10.3 TC
TMSEQ FAULTS CT 10.4 PL
CT MOVE TO PLA BP
SPECT TK
FIX AT BP
EVAC ?
YES
NO
TMSEQ STATUS PL 10.5 TC
ASSIST EVAC 10.6 CR
DEC FI-RE PLAN VIABLE 10.7 PL
PLAN VIABLE ?
YES
NO
TMSEQ CHANGE TC 10.8 PL
EXECUTE CHANGE 10.9 TC
FIX AT BP
DEC HP REQ 10.10 TC
HP REQ ?
YES
NO
TMSEQ MOVE PL 10.11 TC
MMSEQ HP 10.12 CR
PLACE TK IN HP 10.13 CR
CT FIX ?
YES
NO
ASSIST FIX TK 10.15 CR
CR FIX
FIX TK 10.14 CR
AT HP ?
YES
NO
TMSEQ MOVE PL 10.16 TC
MMSEQ PFP 10.17 CR
PLACE TK IN PFP 10.18 CR
NEED EQU/PART ?
YES
NO
HAVE EQU/PART ?
YES
NO
TMSEQ PART PLA 10.19 TC
DES C PICK-UP 10.20 TC
EQU/PART IN PLA ?
YES
NO
TMSEQ PART PL 10.21 TC
TMSEQ PART CT 10.22 PL
CT MOVE PART TO BP
DMSEQ PART LOC 10.23 C
SECURE EQU/PART 10.24 C
DMSEQ BACK TO OWN TK 10.25 C

Fig E-17



IOB
CT TMSEQ SUPPLY PLA
CT DES MODE ?
YES
NO
SEL MODE 10.26 PL
CT SEC ARRIVE BP
TK BY TK MODE ?
TK TO POINT MODE
SEL LOC SUPPLY POINT 10.35 PL
TMSEQ LOC CT SEC 10.36 PL
CT SEC MOVE TO LOC
MAN PORTABLE ?
NOT MAN PORTABLE
TMSEQ SUPPLY TC 10.37 PL
MMSEQ SUPPLY POINT 10.38 CR
PLACE TK IN POS 10.39 CR
TMSEQ TK LOC CT SEC 10.27 PL
CT MOVE BEHIND TK
RO ?
UNPACK RO 10.28 CR
STOW RO 10.29 CR
FUEL ?
FUEL TK 10.30 CR
OTHER ?
STOW OTHER 10.31 CR
POLICE LITTER 10.32 CR
TMSEQ DONE PL 10.33 TC
TK TO POINT ?
TK TO TK
MOTS 10.34 CR
ALL TK DONE ?
MMSEQ BACK TO FP 10.40 CR
PLACE TK IN FP 10.41 CR
TMSEQ SUPPLY TC 10.42 PL
DES C SECURE SUPPLY 10.43 TC
DMSEQ SUPPLY POINT 10.44 C
SECURE SUPPLY 10.45 C
DMSEQ BACK TO OWN TK 10.46 C
TMSEQ DONE PL 10.47 TC
STOW SUPPLY 10.48 CR
POLICE LITTER 10.49 CR
MOTS 10.50 CR

fig E-18

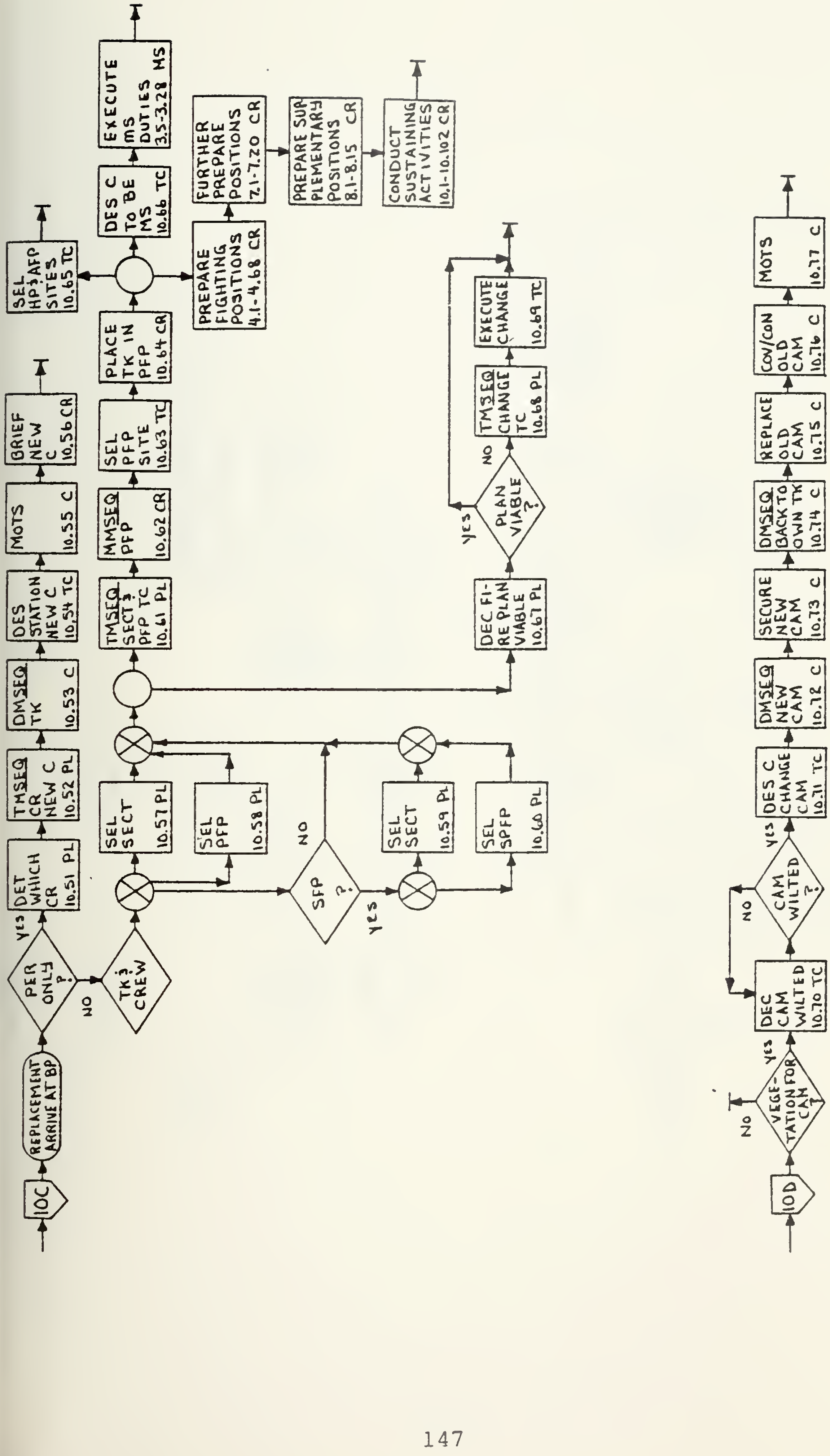

10C
REPLACEMENT ARRIVE AT BP
PER ONLY ?
YES
NO
DET WHICH CR 10.51 PL
TMSEQ CR NEW C 10.52 PL
DMSEQ TK 10.53 C
DES STATION NEW C 10.54 TC
MOTS 10.55 C
BRIEF NEW C 10.56 CR
TK & CREW
SEL SECT 10.57 PL
SEL PFP 10.58 PL
SFP ?
NO
YES
SEL SECT 10.59 PL
SEL SPFP 10.60 PL
TMSEQ SECT & PFP TC 10.61 PL
MMSEQ PFP 10.62 CR
SEL PFP SITE 10.63 TC
PLACE TK IN PFP 10.64 CR
SEL HP & AFP SITES 10.65 TC
DES C TO BE MS 10.66 TC
EXECUTE MS DUTIES 3.5-3.28 MS
PREPARE FIGHTING POSITIONS 4.1-4.68 CR
FURTHER PREPARE POSITIONS 7.1-7.20 CR
PREPARE SUPPLEMENTARY POSITIONS 8.1-8.15 CR
CONDUCT SUSTAINING ACTIVITIES 10.1-10.102 CR
DEC FIRE PLAN VIABLE 10.67 PL
PLAN VIABLE ?
YES
NO
TMSEQ CHANGE TC 10.68 PL
EXECUTE CHANGE 10.69 TC
10D
VEGETATION FOR CAM ?
NO
YES
DEC CAM WILTED 10.70 TC
CAM WILTED ?
NO
YES
DES C CHANGE CAM 10.71 TC
DMSEQ NEW CAM 10.72 C
SECURE NEW CAM 10.73 C
DMSEQ BACK TO OWN TK 10.74 C
REPLACE OLD CAM 10.75 C
CON/CON OLD CAM 10.76 C
MOTS 10.77 C

fig E-19

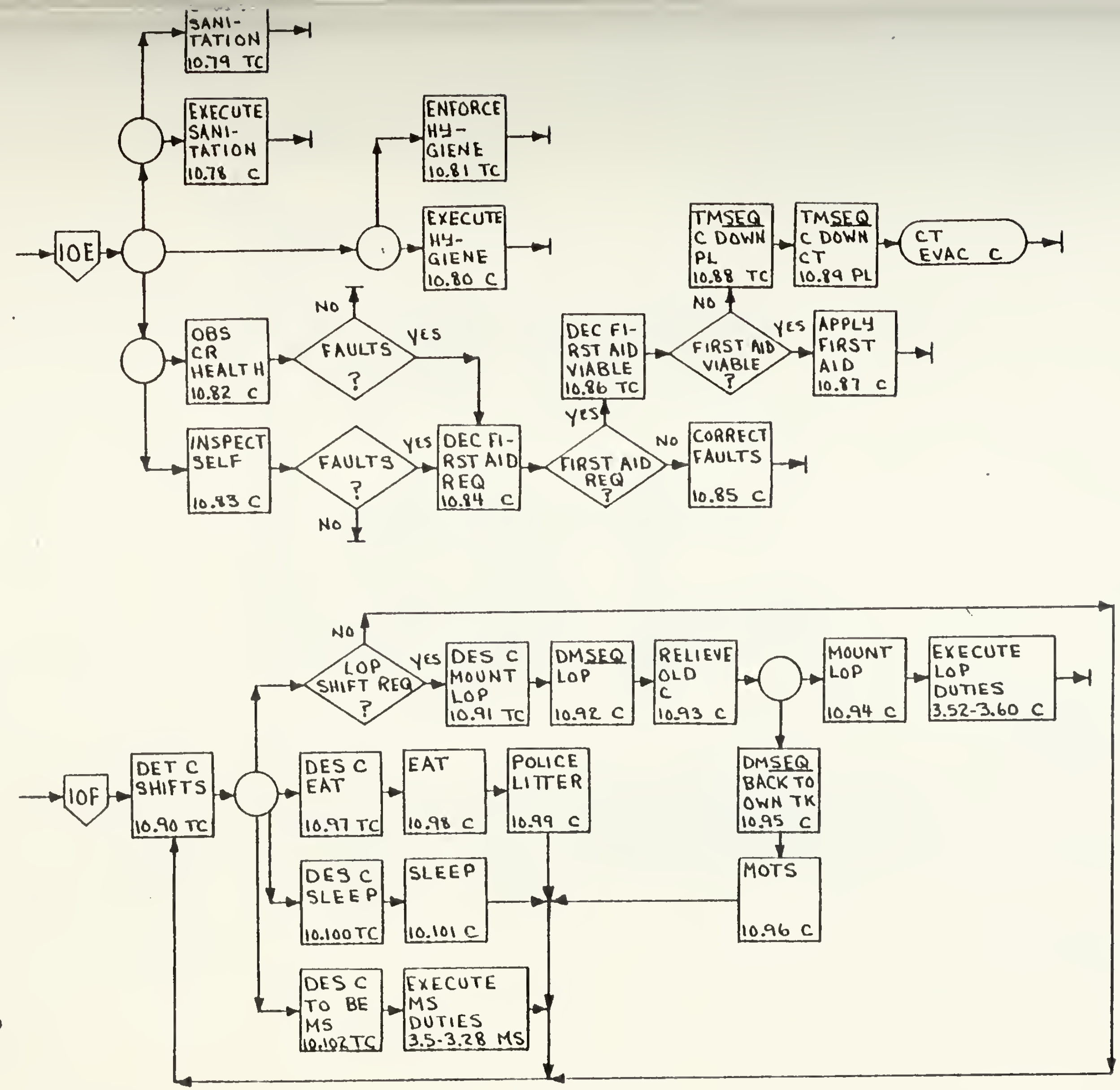

10E
SANITATION 10.79 TC
EXECUTE SANITATION 10.78 C
ENFORCE HYGIENE 10.81 TC
EXECUTE HYGIENE 10.80 C
OBS CR HEALTH 10.82 C
FAULTS ?
NO
YES
INSPECT SELF 10.83 C
DEC FIRST AID REQ 10.84 C
FIRST AID REQ ?
DEC FIRST AID VIABLE 10.86 TC
FIRST AID VIABLE ?
CORRECT FAULTS 10.85 C
TMSEQ C DOWN PL 10.88 TC
TMSEQ C DOWN CT 10.89 PL
CT EVAC C
APPLY FIRST AID 10.87 C
10F
DET C SHIFTS 10.90 TC
LOP SHIFT REQ ?
DES C MOUNT LOP 10.91 TC
DMSEQ LOP 10.92 C
RELIEVE OLD C 10.93 C
MOUNT LOP 10.94 C
EXECUTE LOP DUTIES 3.52-3.60 C
DMSEQ BACK TO OWN TK 10.95 C
MOTS 10.96 C
DES C EAT 10.97 TC
EAT 10.98 C
POLICE LITTER 10.99 C
DES C SLEEP 10.100 TC
SLEEP 10.101 C
DES C TO BE MS 10.102 TC
EXECUTE MS DUTIES 3.5-3.28 MS

fig E-20

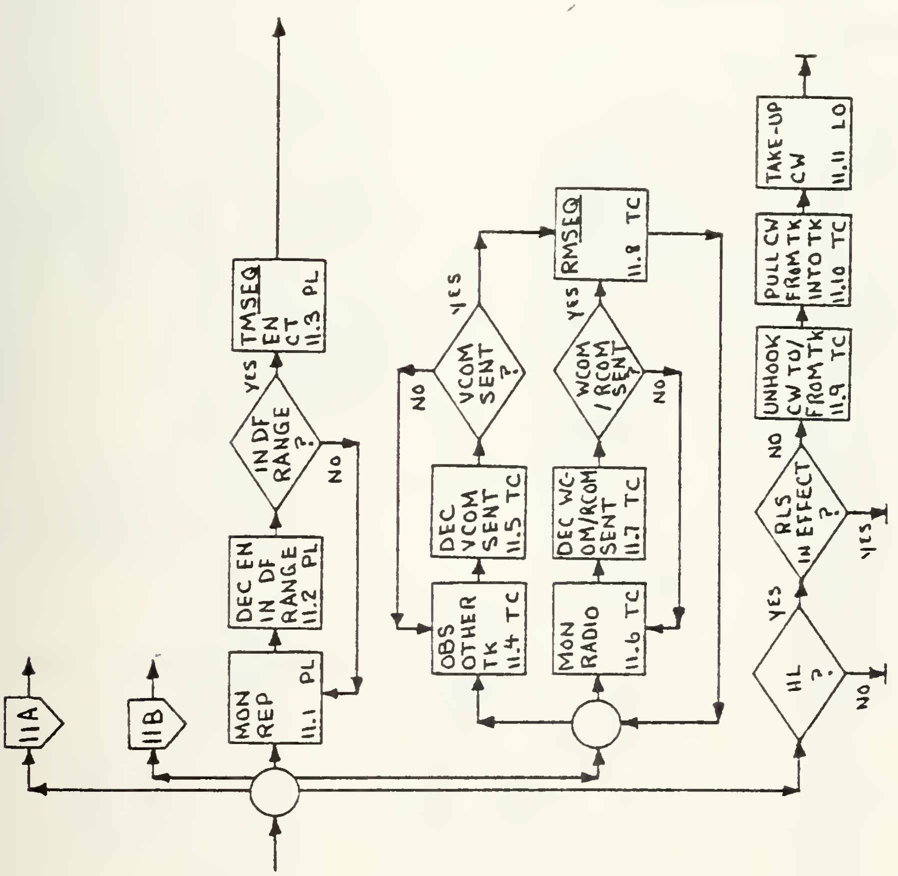

11A
11B
MON REP 11.1 PL
DEC EN IN DF RANGE 11.2 PL
IN DF RANGE ?
YES
NO
TMSEQ EN CT 11.3 PL
OBS OTHER TK 11.4 TC
DEC VCOM SENT 11.5 TC
VCOM SENT ?
YES
NO
RMSEQ 11.8 TC
MON RADIO 11.6 TC
DEC WCOM/RCOM SENT 11.7 TC
WCOM /RCOM SENT ?
YES
NO
HL ?
YES
NO
RLS IN EFFECT ?
YES
NO
UNHOOK CW TO/FROM TK 11.9 TC
PULL CW FROM TK INTO TK 11.10 TC
TAKE-UP CW 11.11 LO

fig E-21

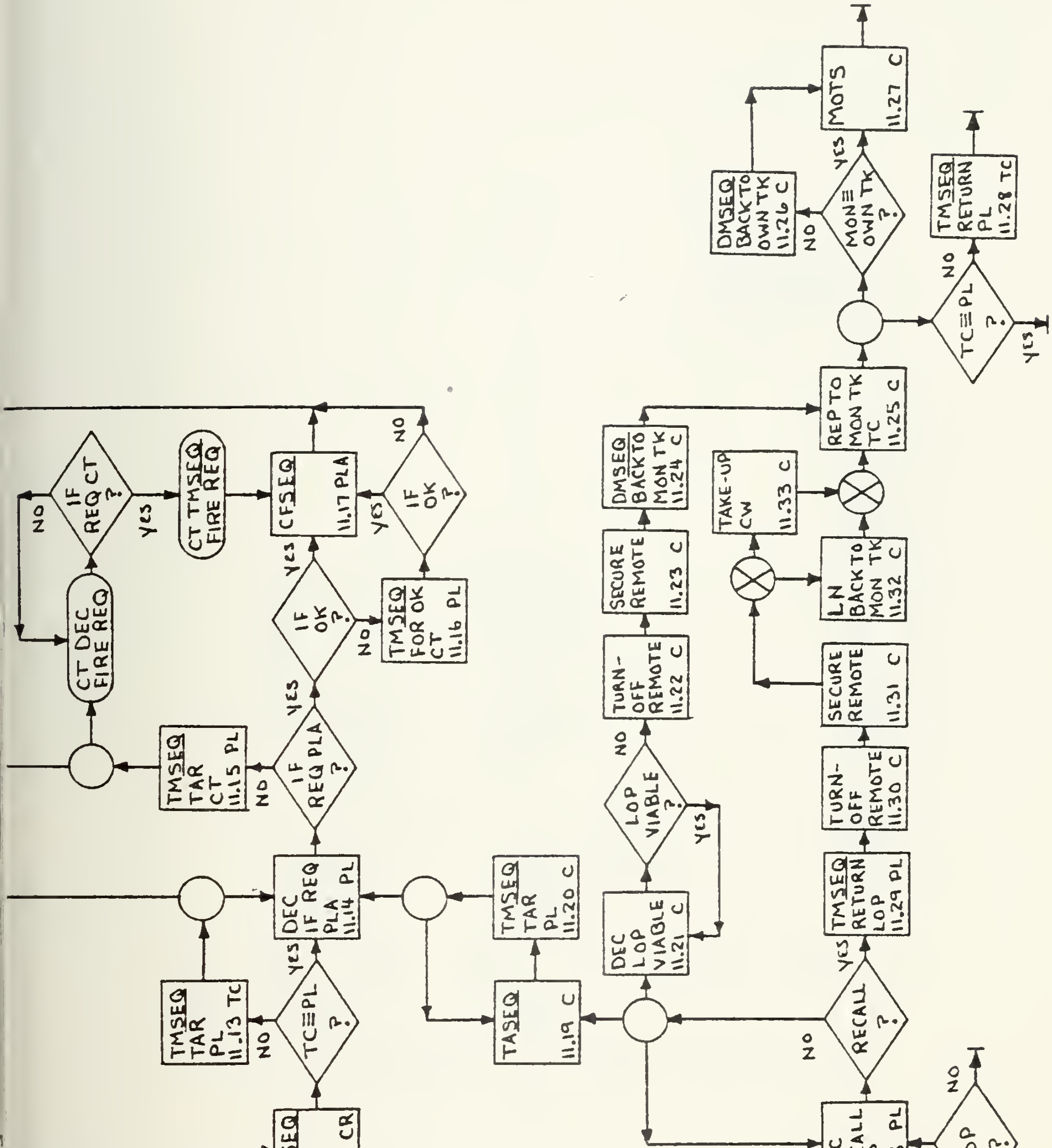
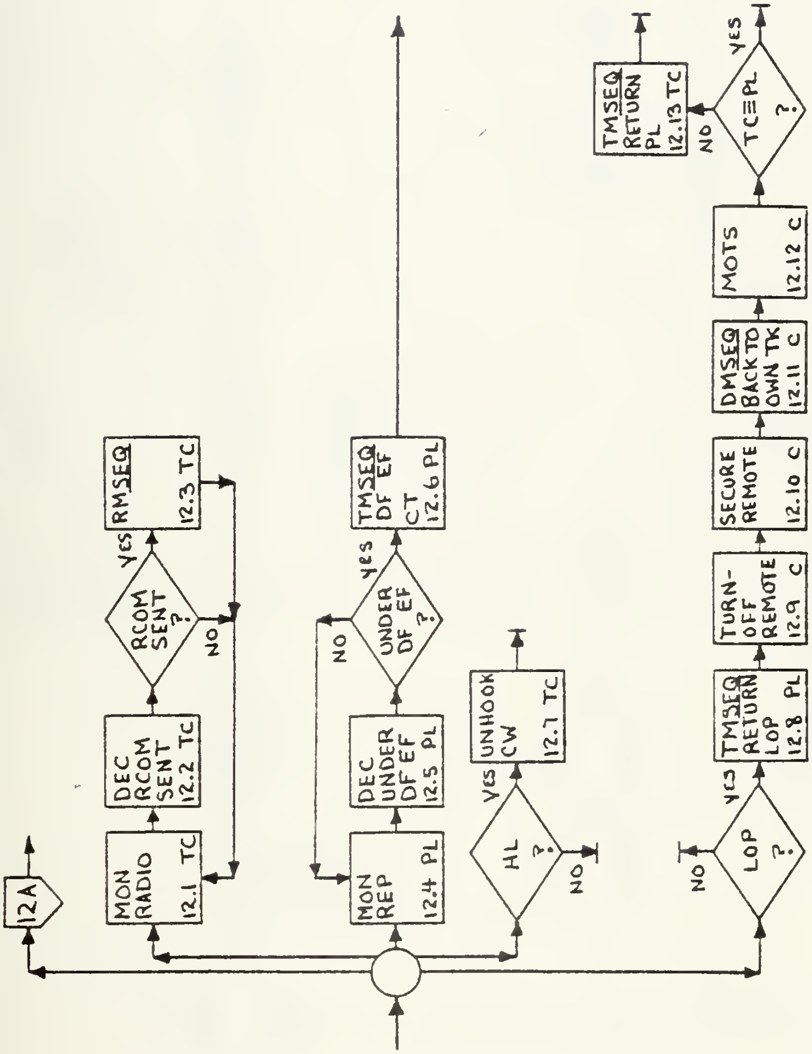
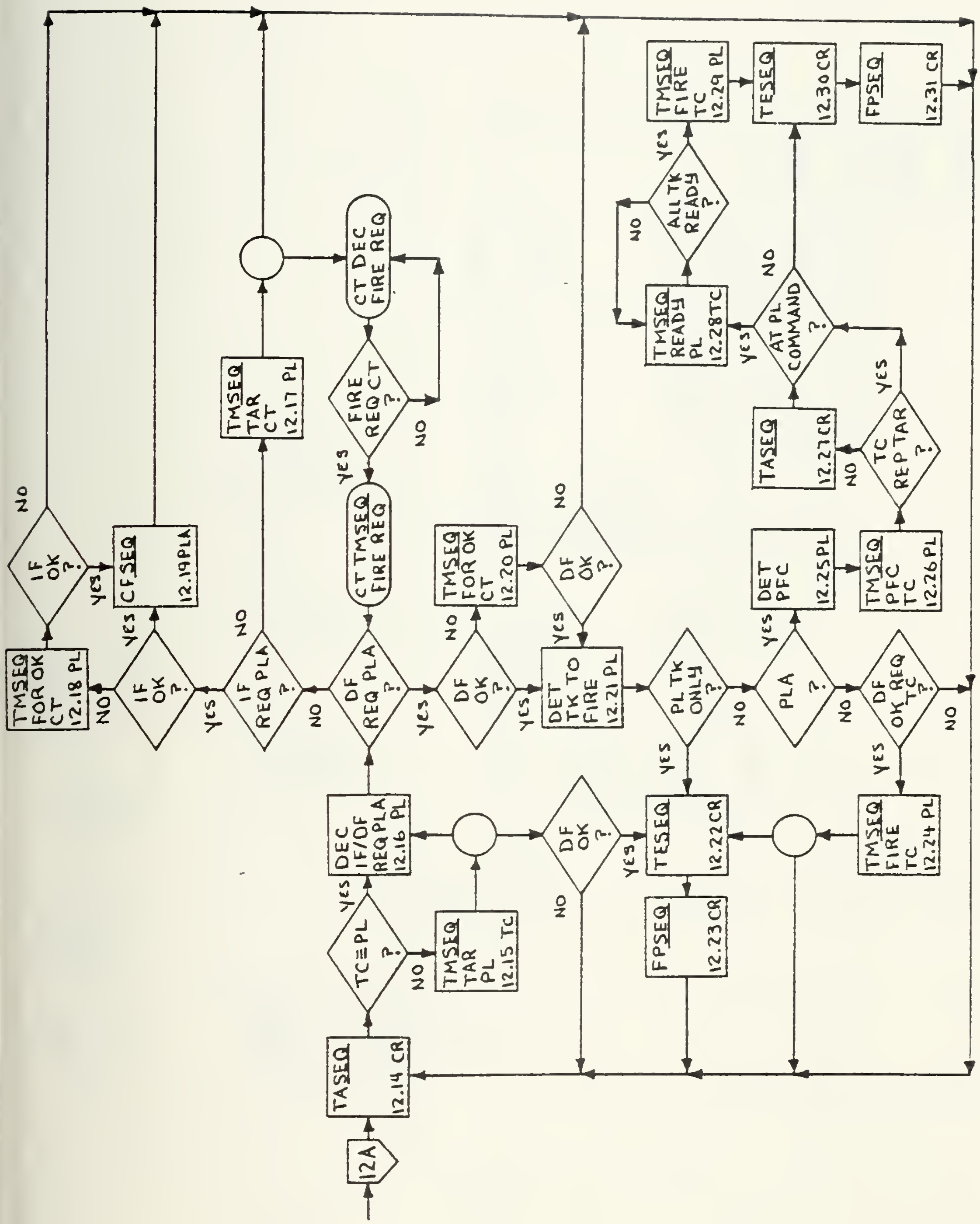

11A
TASEQ 11.12 CR
TC≡PL ?
NO
TMSEQ TAR PL 11.13 TC
YES
DEC IF REQ PLA 11.14 PL
IF REQ PLA ?
TMSEQ TAR CT 11.15 PL
CT DEC FIRE REQ
IF REQ CT ?
CT TMSEQ FIRE REQ
IF OK ?
TMSEQ FOR OK CT 11.16 PL
CFSEQ 11.17 PLA
TASEQ 11.19 C
TMSEQ TAR PL 11.20 C
11B
LOP ?
DEC RECALL LOP 11.18 PL
RECALL ?
DEC LOP VIABLE 11.21 C
LOP VIABLE ?
TURN-OFF REMOTE 11.22 C
SECURE REMOTE 11.23 C
DMSEQ BACK TO MON TK 11.24 C
TMSEQ RETURN LOP 11.29 PL
TURN-OFF REMOTE 11.30 C
SECURE REMOTE 11.31 C
LN BACK TO MON TK 11.32 C
TAKE-UP CW 11.33 C
REP TO MON TK TC 11.25 C
MON≡OWN TK ?
DMSEQ BACK TO OWN TK 11.26 C
MOTS 11.27 C
TC≡PL ?
TMSEQ RETURN PL 11.28 TC

Fig E-22



12A
MON RADIO 12.1 TC
DEC RCOM SENT 12.2 TC
RCOM SENT ?
YES
NO
RMSEQ 12.3 TC
MON REP 12.4 PL
DEC UNDER DF EF 12.5 PL
UNDER DF EF ?
YES
NO
TMSEQ DF EF CT 12.6 PL
HL ?
YES
NO
UNHOOK CW 12.7 TC
LOP ?
YES
NO
TMSEQ RETURN LOP 12.8 PL
TURN-OFF REMOTE 12.9 C
SECURE REMOTE 12.10 C
DMSEQ BACK TO OWN TK 12.11 C
MOTS 12.12 C
TC≡PL ?
YES
NO
TMSEQ RETURN PL 12.13 TC

fig E-23



12A
TASEQ 12.14 CR
TC≡PL ?
YES
NO
TMSEQ TAR PL 12.15 TC
DEC IF/DF REQPLA 12.16 PL
DF OK ?
TESEQ 12.22 CR
FPSEQ 12.23 CR
DF REQ PLA ?
IF REQ PLA ?
IF OK ?
TMSEQ FOR OK CT 12.18 PL
IF OK ?
CFSEQ 12.19PLA
TMSEQ TAR CT 12.17 PL
CT DEC FIRE REQ
FIRE REQ CT ?
CT TMSEQ FIRE REQ
DF OK ?
TMSEQ FOR OK CT 12.20 PL
DF OK ?
DET TK TO FIRE 12.21 PL
PL TK ONLY ?
PLA ?
DET PFC 12.25PL
DF OK REQ TC ?
TMSEQ FIRE TC 12.24 PL
TMSEQ PFC TC 12.26PL
TC REP TAR ?
TASEQ 12.27CR
AT PL COMMAND ?
TMSEQ READY PL 12.28TC
ALL TK READY ?
TMSEQ FIRE TC 12.29 PL
TESEQ 12.30CR
FPSEQ 12.31 CR

fig E-24

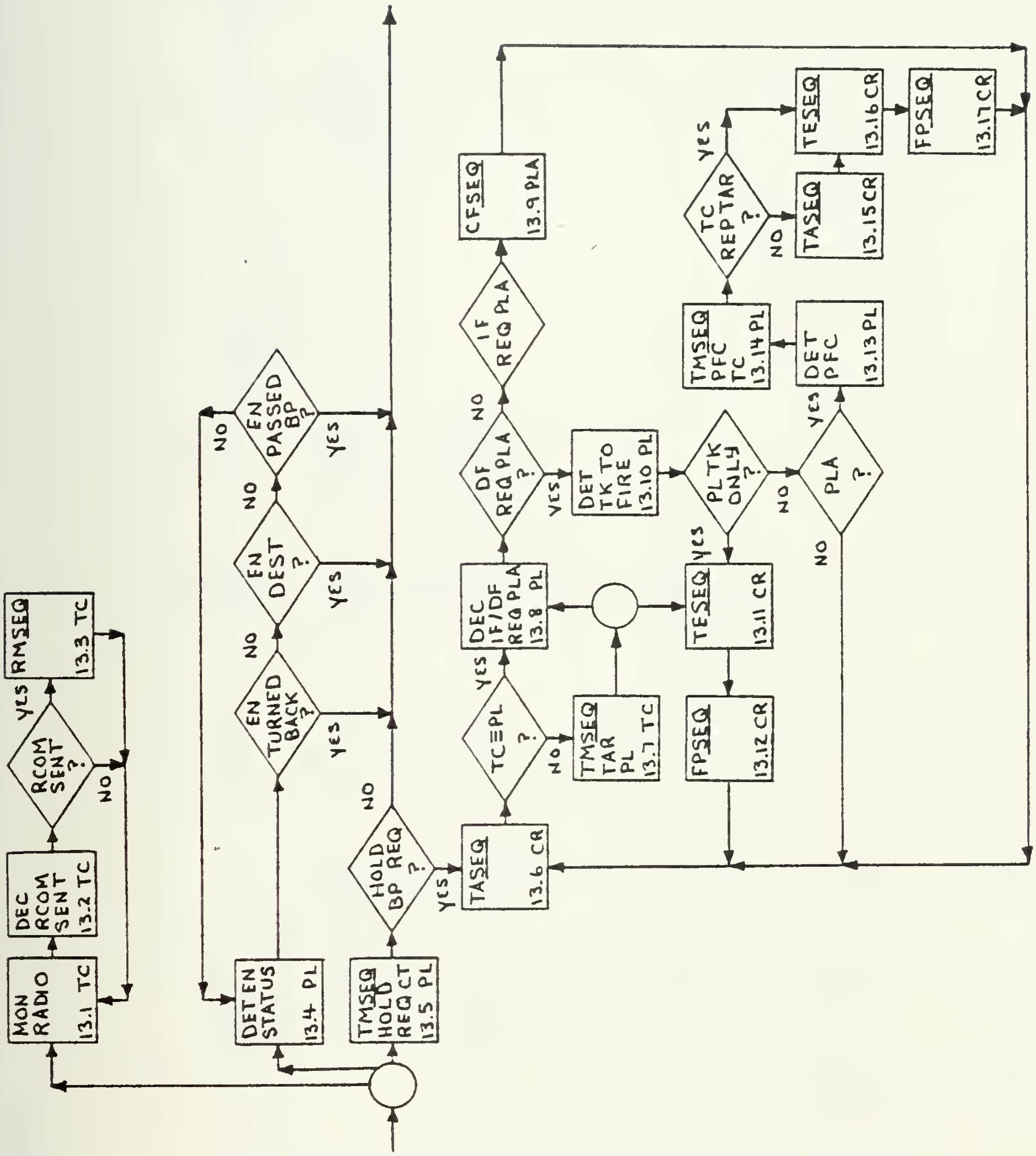

MON RADIO 13.1 TC
DEC RCOM SENT 13.2 TC
RCOM SENT ?
RMSEQ 13.3 TC
DET EN STATUS 13.4 PL
EN TURNED BACK
EN DEST ?
EN PASSED BP
TMSEQ HOLD REQ CT 13.5 PL
HOLD BP REQ ?
TASEQ 13.6 CR
TC≡PL ?
TMSEQ TAR PL 13.7 TC
DEC IF/DF REQ PLA 13.8 PL
DF REQ PLA ?
IF REQ PLA
CFSEQ 13.9 PLA
DET TK TO FIRE 13.10 PL
TESEQ 13.11 CR
FPSEQ 13.12 CR
PL TK ONLY ?
PLA ?
DET PFC 13.13 PL
TMSEQ PFC TC 13.14 PL
TC REPTAR ?
TASEQ 13.15 CR
TESEQ 13.16 CR
FPSEQ 13.17 CR
YES
NO

Fig E-25

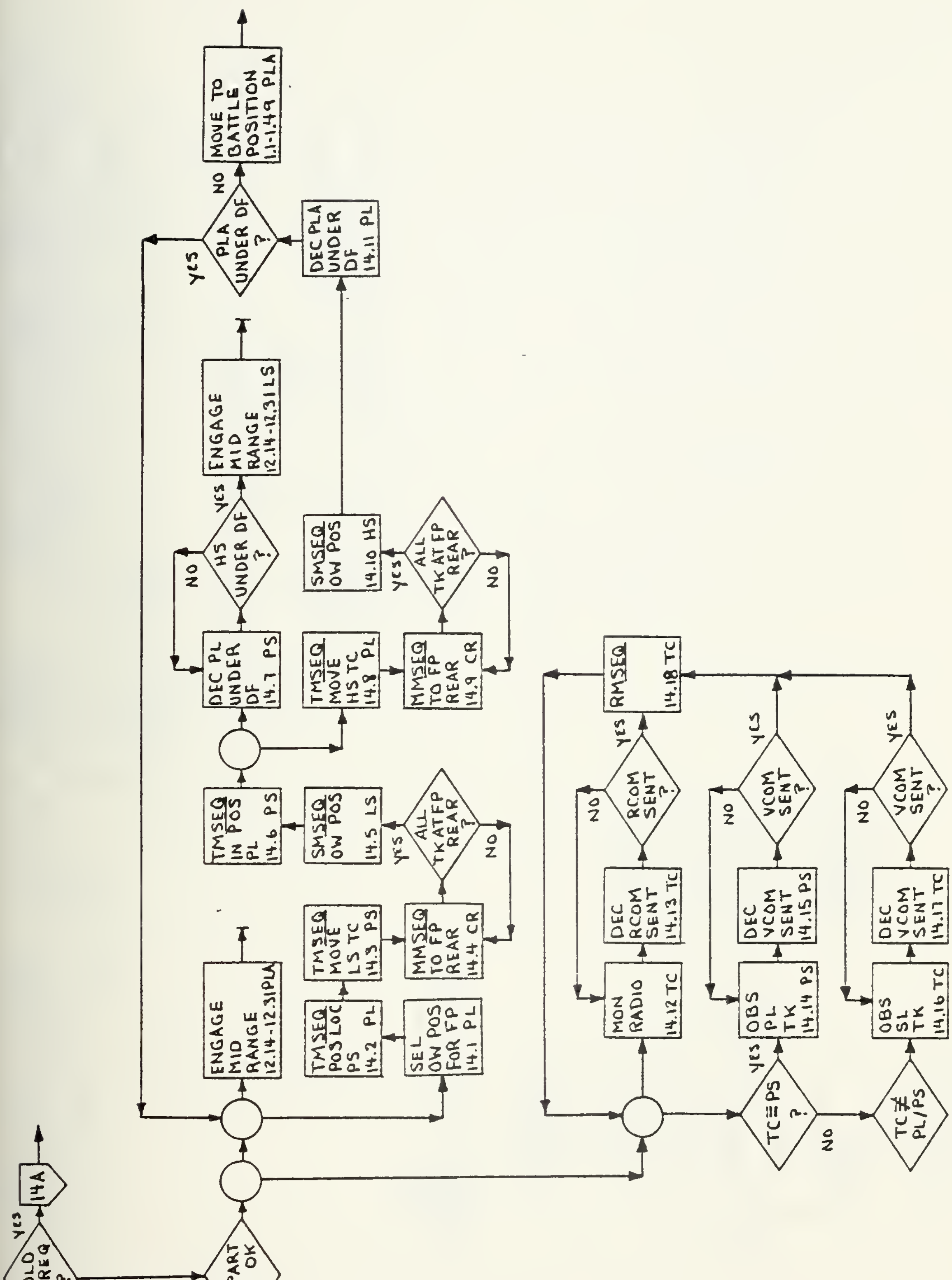

HOLD BP REQ ?
YES
NO
14A
DEPART BP OK
ENGAGE MID RANGE 12.14-12.31 PLA
TMSEQ POS LOC PS 14.2 PL
TMSEQ MOVE LS TC 14.3 PS
SEL OW POS FOR FP 14.1 PL
MMSEQ TO FP REAR 14.4 CR
TMSEQ IN POS PL 14.6 PS
SMSEQ OW POS 14.5 LS
ALL TK AT FP REAR ?
DEC PL UNDER DF 14.7 PS
TMSEQ MOVE HS TC 14.8 PL
MMSEQ TO FP REAR 14.9 CR
HS UNDER DF ?
SMSEQ OW POS 14.10 HS
ENGAGE MID RANGE 12.14-12.31 LS
PLA UNDER DF ?
DEC PLA UNDER DF 14.11 PL
MOVE TO BATTLE POSITION 1.1-1.49 PLA
TC≡PS ?
MON RADIO 14.12 TC
DEC RCOM SENT 14.13 TC
RCOM SENT ?
RMSEQ 14.18 TC
OBS PL TK 14.14 PS
DEC VCOM SENT 14.15 PS
VCOM SENT ?
TC≢ PL/PS
OBS SL TK 14.16 TC
DEC VCOM SENT 14.17 TC

fig E-26

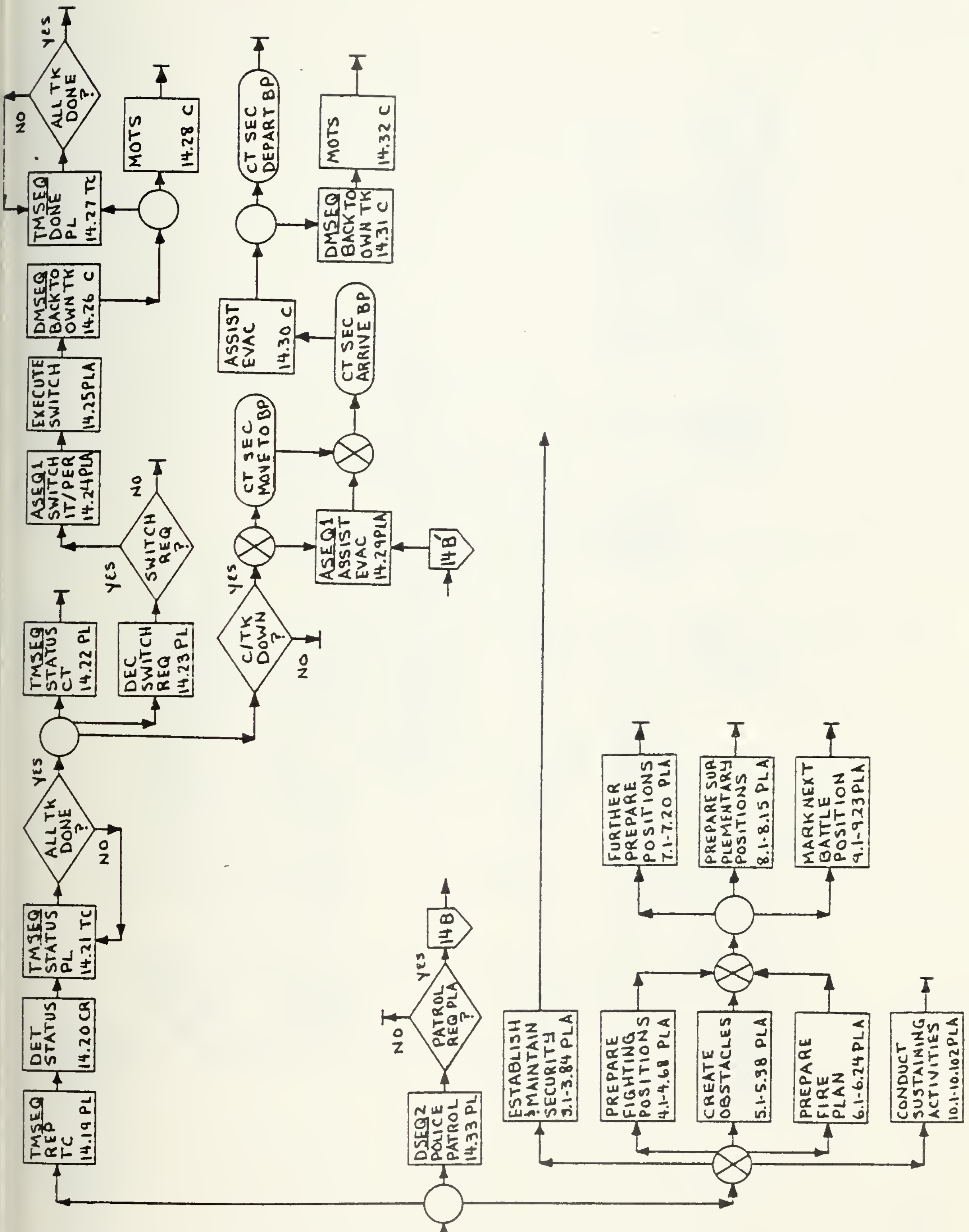

14A
TMSEQ REP TC 14.19 PL
DET STATUS 14.20 CR
TMSEQ STATUS PL 14.21 TC
ALL TK DONE ?
YES
NO
TMSEQ STATUS CT 14.22 PL
DEC SWITCH REQ 14.23 PL
SWITCH REQ ?
YES
NO
ASEQ1 SWITCH IT/PER 14.24 PLA
EXECUTE SWITCH 14.25 PLA
DMSEQ BACK TO OWN TK 14.26 C
TMSEQ DONE PL 14.27 TC
ALL TK DONE ?
YES
NO
MOTS 14.28 C
C/TK DOWN ?
YES
NO
ASEQ1 ASSIST EVAC 14.29 PLA
14B
CT SEC MOVE TO BP
CT SEC ARRIVE BP
ASSIST EVAC 14.30 C
CT SEC DEPART BP
DMSEQ BACK TO OWN TK 14.31 C
MOTS 14.32 C
DSEQ2 POLICE PATROL 14.33 PL
PATROL REQ PLA ?
YES
NO
14B
ESTABLISH & MAINTAIN SECURITY 3.1-3.84 PLA
PREPARE FIGHTING POSITIONS 4.1-4.68 PLA
CREATE OBSTACLES 5.1-5.38 PLA
PREPARE FIRE PLAN 6.1-6.24 PLA
CONDUCT SUSTAINING ACTIVITIES 10.1-10.102 PLA
FURTHER PREPARE POSITIONS 7.1-7.20 PLA
PREPARE SUPPLEMENTARY POSITIONS 8.1-8.15 PLA
MARK NEXT BATTLE POSITION 9.1-9.23 PLA

fig E-27

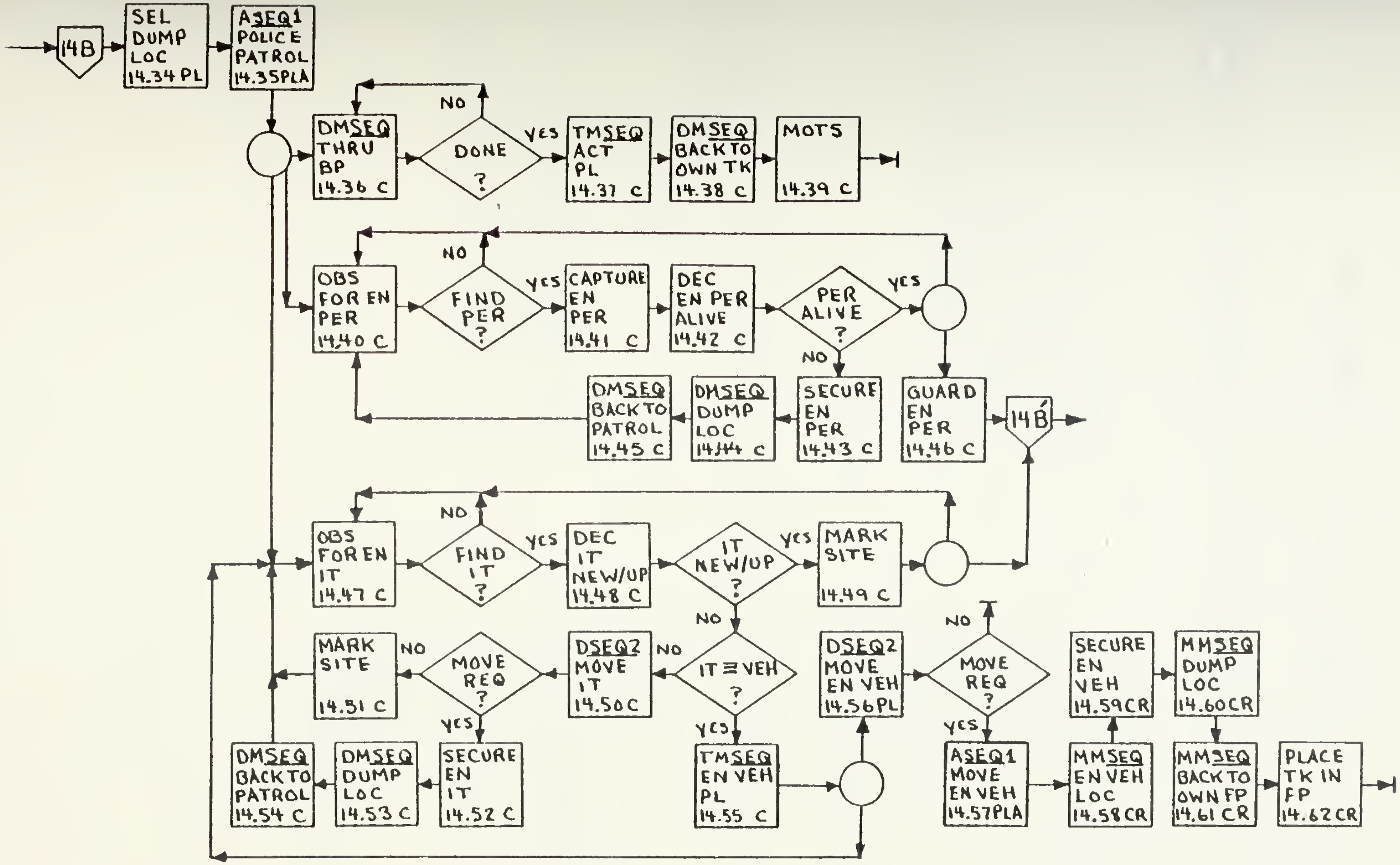

14B
SEL DUMP LOC 14.34 PL
ASEQ1 POLICE PATROL 14.35PLA
DMSEQ THRU BP 14.36 C
DONE ?
NO
YES
TMSEQ ACT PL 14.37 C
DMSEQ BACK TO OWN TK 14.38 C
MOTS 14.39 C
OBS FOR EN PER 14.40 C
FIND PER ?
CAPTURE EN PER 14.41 C
DEC EN PER ALIVE 14.42 C
PER ALIVE ?
SECURE EN PER 14.43 C
DMSEQ DUMP LOC 14.44 C
DMSEQ BACK TO PATROL 14.45 C
GUARD EN PER 14.46 C
14B′
OBS FOR EN IT 14.47 C
FIND IT ?
DEC IT NEW/UP 14.48 C
IT NEW/UP ?
MARK SITE 14.49 C
DSEQ2 MOVE IT 14.50C
IT ≡ VEH ?
MOVE REQ ?
MARK SITE 14.51 C
SECURE EN IT 14.52 C
DMSEQ DUMP LOC 14.53 C
DMSEQ BACK TO PATROL 14.54 C
TMSEQ EN VEH PL 14.55 C
DSEQ2 MOVE EN VEH 14.56PL
ASEQ1 MOVE EN VEH 14.57PLA
MMSEQ EN VEH LOC 14.58CR
SECURE EN VEH 14.59CR
MMSEQ DUMP LOC 14.60CR
MMSEQ BACK TO OWN FP 14.61 CR
PLACE TK IN FP 14.62CR

fig E-28

APPENDIX F

PERFORMANCE MEASURE SUMMARY

ASK: Decide if destination can be seen given proxy destination designation.

MEASURES

- Radial error between actual destination location and perceived destination location
- Task accomplishment time
- Attention focus

FACTORS

- Designation method selected
- Time since last training
- Terrain features
- Vegetation
- Visibility
- Compass deflection error (polar coordinates only)

ASK: Select route on map or ground for mounted or dismounted movement given proxy or physical destination designation.

MEASURES

- Ordinal ranking of candidate routes for given situation
- Task accomplishment time
- Attention focus

FACTORS

- Selection medium
- Movement mode
- Time since last training
- Terrain features
- Soil types
- Grades
- Vegetation
- Visibility
- Acceptable risk

ASK: Land navigate while mounted or dismounted

MEASURES	FACTORS
o Radial error between perceived destination location and physical location selected as perceived destination location (proxy destination only) o Radial error between actual destination location and physical location selected as perceived destination location (physical location only) o Linear error between actual destination location and physical location selected as perceived destination location (route marked beyond destination only)	o Designation method o Movement mode o Time since last training o Terrain features o Vegetation o Visibility o Distance travelled o Deviation from baseline (proxy designation only)
o Projected area of unconcealed portion of crewman and equipment carried or of tank o Duration of each size area	o Movement mode o Time since last training o Terrain features o Vegetation o Rate of movement o Presence of other crewmen o Acceptable risk
o Projected area of uncovered portion of crewman or tank o Duration of each size area	o Movement mode o Time since last training o Terrain features o Vegetation (crewman only) o Rate of movement o Presence of other crewmen o Acceptable risk

ASK: Land navigate while mounted or dismounted, CONT.

MEASURES	FACTORS
o Reflected and emitted light intensity and wavelength o Duration of each light type	o Movement mode o Time since last training o Terrain features o Vegetation o Visibility o Camouflage amount and type o Presence of other crewmen o Acceptable risk
o Emitted noise intensity and wavelength o Duration of each noise type	o Movement mode o Time since last training o Soil types (tank only) o Grades (tank only) o Vegetation o Rate of movement o Engine type, age, and speed (tank only) o Suspension type and age (tank only) o Presence of other crewmen o Acceptable risk
o Task accomplishment time	o Movement mode o Soil types o Grades o Vegetation (crewman only) o Ground pressure o Physical stamina (crewman only) o Transmission torque (tank only) o Previous route use o Acceptable risk o Rate of movement selection

ASK: Direct driver

MEASURES	FACTORS
o Task accomplishment time o Attention focus	o Time since last training o Terrain features o Vegetation o Visibility o Acceptable risk o Verbal skills

ASK: Operate tank

MEASURES	FACTORS
o Response time to instructions	o Time since last training o Verbal skills
o Projected area of unconcealed portion of exhaust signature and particle size and density o Projected area of unconcealed portion of dust signature and particle size and density o Duration of each area and particle size and density	o Time since last training o Terrain features o Soil types (movement only) o Grades (movement only) o Vegetation o Atmospheric conditions o Rate of movement o Engine type, age and speed o Presence of other crewmen o Acceptable risk

ASK: Select fighting position site

MEASURES	FACTORS
o Ordinal ranking of candidate positions for given situation o Task accomplishment time o Attention focus	o Time since last training o Terrain features o Soil types o Grades o Vegetation o Visibility o Acceptable risk

ASK: Place tank in fighting position site

MEASURES	FACTORS
o Amount of mask clearance o Radial error between desired and actual tank center of mass (marking and staking methods only) o Deflection error between desired and actual hull orientation (marking and staking methods only) o Deflection error between desired and actual turret orientation (staking method only)	o Site definition method o Time since last training o Terrain features (mask clearance only) o Soil types o Grades o Vegetation (mask clearance only) o Visibility o Ground pressure o Transmission torque o Elevation error between sight and cannon (mask clearance only) o Azimuth indicator error (staking method only) o Activity delegation o Marking and staking amount, material, and technique (marking and staking methods only) o Acceptable risk o Activity delegation selection
o Projected area of unconcealed portion of tank o Projected area of uncovered portion of tank	o Terrain features o Vegetation (concealment only)

ASK: Place tank in fighting position site, CONT

MEASURES	FACTORS
o Reflected and emitted light intensity and wavelength o Duration of each light type	o Time since last training o Terrain features o Vegetation o Visibility o Camouflage amount and type o Presence of other crewmen o Acceptable risk
o Emitted noise intensity and wavelenth o Duration of each noise type	o Time since last training o Engine type, age and speed o Presence of other crewman o Acceptable risk
o Task accomplishment time o Attention focus of participating crewmen	o Site definition method o Time since last training o Soil types o Grades o Visibility o Ground pressure o Transmission torque o Activity delegation o Marking and staking amount, material, and technique (marking and staking methods only) o Acceptable risk o Activity delegation selection

ASK: Designate and instruct crewman to perform a task

MEASURES	FACTORS
o Task accomplishment time o Attention focus of participating crewmen	o Acceptable risk o Verbal skills

ASK: Mount own tank station upon completion of task outside tank

MEASURES	FACTORS
o Proportion of times remount delayed for given situation	o Time since last training
o Duration of each delay	o Immediate retasking
	o Presence of other crewmen
	o Acceptable risk

o Projected area of unconcealed portion of crewman and equipment carried	o Time since last training
o Projected area of uncovered portion of crewman	o Terrain features
o Duration of each area	o Vegetation
	o Tank location
	o Rate of movement
	o Acceptable risk
	o Rate of movement selection

ASK: Decide if physical delivery is best means of message delivery

MEASURES	FACTORS
o Proportion of times physical delivery is selected for given message	o Time since last training
o Task accomplishment time	o Nature of message
o Attention focus	

ASK: Decide if messenger is viable to physically deliver message

MEASURES	FACTORS
o Proportion of times delivery by messenger or tank is selected for given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Visibility
	o Distance between sender and recipient
	o Acceptable risk

TASK: Deliver message to addressee

MEASURES	FACTORS
o Task accomplishment time	o Message medium
o Attention focus of participating crewmen	o Verbal skills

TASK: Decide if visual signals are viable

MEASURES	FACTORS
o Proportion of times hand and arm, visual, and flashlight signals are selected by type for given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Visibility
	o Distance between sender and addressee
	o Apparent focus of addressee's attention
	o Acceptable risk
	o Addressee's actual focus of attention
	o Perceived message complexity

TASK: Transmit message by visual signals, wire, or radio

MEASURES	FACTORS
o Proportion of times visual signal, wire, or radio is used for given situation	o Transmission method
o Signal intensity and wavelength (radio only)	o Time since last training
o Light intensity and wavelength (flashlight only)	o Terrain features (visual signals and radio only)
o Duration of signal or light	o Vegetation (visual signals and radio only)
o Task accomplishment time	o Visibility (visual signals only)
o Attention focus	o Atmospheric conditions (radio only)
	o Distance between sender and recipient
	o Light intensity and wavelength (flashlight only)
	o Radio listening silence in effect
	o Wire communication available
	o Radio system type and age used by sender and recipient (radio only)
	o Signal intensity and wavelength (radio only)
	o Response time of addressee
	o Perceived message complexity

ASK: Decide if message received

MEASURES	FACTORS
o Proportion of times message is considered received for given situation o Task accomplishment time o Attention focus	o Transmission method o Time since last training o Terrain features o Soil types (messenger only) o Grades (messenger only) o Vegetation o Visibility o Distance between sender and recipient (messenger only) o Return of messenger (messenger only) o Report of messenger (messenger only) o Reasonable time (messenger only) o Acknowledgement of message o Unit standard operating procedure (visual signals only) o Nature of action required by message o Acceptable risk o Reasonable time selection (messenger only)

ASK: Decide if message understood

MEASURES	FACTORS
o Proportion of times message is considered understood in given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Visibility
	o Nature of action required by message
	o Acceptable risk
	o Verbal skills

ASK: Decide if understand message

MEASURES	FACTORS
o Proportion of times message is considered understandable in given situation	o Time since last training
o Task accomplishment time	o Verbal skills
o Attention focus	

ASK: Decide if message requires answer

MEASURES	FACTORS
o Proportion of times answer is considered required in given situation	o Transmission method
o Task accomplishment time	o Time since last training
o Attention focus	o Unit standard operating procedure (visual signals only)
	o Nature of action required by message
	o Verbal skills

ASK: Decide whether to imitate section leader's actions or request message repeat or clarify if message not understandable

MEASURES	FACTORS
o Proportion of times selected option is chosen in given situation	o Time since last training
o Task accomplishment time	o Nature of platoon current activity
o Attention focus	o Identity of recipient

'ASK: Observe and listen in sector

MEASURES	FACTORS
o Portion of time spent observing in each section of sector in given situation o Attention focus	o Time since last training o Terrain features o Vegetation o Visual acuity o Vision enhancement device type and age o Scanning method o Previously identified activity or target o Acceptable risk o Scanning method selection o Visibility o Atmospheric conditions o Aural acuity

'ASK: Decide if there is activity in sector

MEASURES	FACTORS
o Proportion of times an activity is detected in given situation o Task accomplishment time o Attention focus	o SEE FACTORS FOR NEXT TASK

ASK: Decide if activity is live, potential target

MEASURES	FACTORS
o Proportion of times target is recognized in given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Visibility
	o Atmospheric conditions
	o Presence, rate of movement, and projected unconcealed area of aircraft, vehicles, personnel, and animals
	o Presence, projected unconcealed area, and particle size and density of dust and smoke
	o Presence, intensity, and wavelength of noise and light
	o Distance between observer and activity
	o Visual acuity
	o Aural acuity
	o Vision enhancement device type and age
	o Acceptable risk

TASK: Inform tank commander of acquired target

MEASURES	FACTORS
o Proportion of times tank commander informed when appropriate o Task accomplishment time	o Time since last training o Verbal skills

TASK: Decide if under effective fire

MEASURES	FACTORS
o Proportion of times elements considered under effective fire for given situation o Task accomplishment time o Attention focus	o Time since last training o Terrain features o Vegetation o Visibility o Ordnance type o Impact location in relation to platoon location o Firing signature and location in relation to platoon location o Tank damage o Crewman casualties o Acceptable risk o Perceived ordnance effects on platoon movement

TASK: Decide if effective fire is direct, indirect, or mixture

MEASURE	FACTORS
o Proportion of times elements considered under effective direct, indirect, or mixed fire for given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Visibility
	o Ordnance type
	o Ordnance terminal effects
	o Impact location in relation to platoon location
	o Firing signature and location in relation to platoon location
	o Tank damage
	o Crewman casualties

TASK: Select platoon sectors of observation

MEASURES	FACTORS
o Ordinal ranking of candidate sets of sectors for given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Visibility
	o Acceptable risk

TASK: Designate crew sectors of observation

MEASURES	FACTORS
o Ordinal ranking of candidate sets of sectors for given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus of participating crewmen	o Vegetation
	o Visibility
	o Hatches open or closed
	o Acceptable risk
	o Hatches' position selection

TASK: Select platoon movement technique

MEASURES	FACTORS
o Proportion of times each movement technique is selected for given situation	o Time since last training
o Task accomplishment time	o Potential enemy locations in relation to platoon location
o Attention focus	o Acceptable risk

TASK: Reselect platoon movement technique

MEASURES	FACTORS
o Proportion of times each movement technique is selected for given situation change	o Time since last training
o Task accomplishment time	o Potential enemy locations in relation to platoon location
o Attention focus	o Acceptable risk

TASK: Determine most dangerous potential enemy position

MEASURES	FACTORS
o Ordinal ranking of candidate positions for given situation	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Soil types
	o Grades
	o Vegetation
	o Visibility
	o Distance between present heavy section location and candidate potential enemy position location
	o Acceptable risk

TASK: Select platoon or section position during platoon movement

MEASURES	FACTORS
o Ordinal ranking of candidate positions for given situation	o Element size
o Task accomplishment time	o Time since last training
o Attention focus	o Terrain features
	o Soil types
	o Grades
	o Vegetation
	o Visibility
	o Distance between most dangerous potential enemy position and candidate position
	o Acceptable risk

TASK: Decide if light section can halt in overwatch position

MEASURES	FACTORS
o Proportion of times either option is selected for given situation	o Time since last training
o Task accomplishment time	o Distance between present heavy section location and most dangerous potential enemy position
o Attention focus	o Rate of movement of heavy section
	o Distance between present heavy section location and light section position

TASK: Decide if light section overwatch position still viable

MEASURES	FACTORS
o Proportion of times either option is selected for given situation	o Time since last training
o Task accomplishment time	o Distance between present heavy section location and most dangerous potential enemy position
o Attention focus	o Distance between present heavy section location and light section position

ASK: Observe for visual signals

MEASURES

- Portion of time spent observing for signals
- Attention focus

FACTORS

- Observer identity
- Time since last training
- Terrain features
- Vegetation
- Visibility
- Acceptable risk

ASK: Decide if visual signal sent

MEASURES

- Proportion of times recipient decides visual signal sent given message sent
- Task accomplishment time
- Attention focus

FACTORS

- Type of visual signal
- Time since last training
- Terrain features
- Vegetation
- Visibility
- Recipient visual acuity
- Light intensity and wavelength (flashlight signal only)
- Distance between sender and recipient locations

TASK: Monitor radio

MEASURES	FACTORS
o Portion of time spent monitoring radio	o Time since last training
o Attention focus	o Terrain features
	o Vegetation
	o Atmospheric conditions
	o Acceptable risk

TASK: Decide if message sent

MEASURES	FACTORS
o Proportion of times recipient decides radio message sent given message sent	o Time since last training
o Task accomplishment time	o Terrain features
o Attention focus	o Vegetation
	o Atmospheric conditions
	o Recipient aural acuity
	o Signal intensity and wavelenth
	o Radio systems type and age used by sender and recipient
	o Distance between sender and recipient locations

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